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From L'Illustrazione Italiana

Preparing a heavy howitzer for a bombardment

A BIG GUN ON THE ITALIAN FRONT

Pulverized Coal as a Fuel*

A System that Promotes Efficiency and Conservation of Supplies

By Henry G. Barnhurst

PULVERIZED coal was first applied successfully for economical reasons in connection with the burning of Portland cement. The growth of the Portland cement industry also had a great bearing on the development and use of pulverized coal in that it is in this industry that pulverizing machines were brought to the present high state of development, for in the manufacture of cement not only the coal is pulverized, but for each barrel of cement manufactured weighing 380 pounds there are required about 600 pounds of raw material such as limestone shale or cement rock, as well as the 380 pounds of clinker produced by the kilns which must be pulverized in order to make the finished product, so that in the neighborhood of 1,100 pounds of raw materials, clinker and coal must be ground to produce one barrel of Portland cement. As there are a hundred million barrels of Portland cement made in this country annually, these figures will give one a reason why pulverizing machines have been so highly developed during the last few years. Fine grinding of the raw material means reduction in the quantity of fuel required and also makes possible the highest quality of the finished product, so far as the chemical analysis or combination is concerned. Fine grinding of the clinker means increased strength for the reason that the hydraulically active units in cement are in direct proportion to the percentage of fines or impalpable powder in the finished product.

Somewhere between thirty and fifty million tons of pulverized coal have been used to date in the manufacture of cement alone. The application of this ideal form of fuel has been gradually taken up by engineers connected with other industries who have speedily recognized its value to such an extent that the steel industry today is using in the neighborhood of 2,000,000 tons of pulverized coal annually in various types of furnaces such as open hearth, heating, puddling, soaking pits, continuous heating, reheating, annealing, forging furnaces and furnaces of practically every description where heat is required, and is being used successfully.

It is evident that the future possibilities of the application of pulverized coal are now being recognized by the large steel companies as a subject worthy of their careful investigation; this is proven by the number of applications now operating and contracted for. The results already obtained make it apparent that this form of fuel will replace other methods of firing in a great many cases.

A great development is going on in the application and use of pulverized coal in connection with the copper industry; ore roasting furnaces, reverberatory and copper melting furnaces of all types are now successfully operating with this form of fuel, and between one and two million tons of pulverized coal are used in this industry alone each year.

Another large field in which pulverized coal is commanding attention is in its application to rotary kilns for the desulphurizing and roasting of various grades of ores and also nodulizing flue dust so as to make available products heretofore rather expensive to recover. In one installation ore is now being treated at the rate of 800 to 1,000 tons daily requiring from 250 to 300 pounds of coal per ton of ore desulphurized and nodulized.

In another large installation ores carrying as high as 40 per cent moisture and of rather a soft nature are being successfully handled requiring from 400 to 500 pounds of pulverized coal per ton of ore nodulized.

Pulverized coal is being successfully used today in the burning of lime in rotary kilns for making oxide of lime for use in the openhearth furnaces, also for burning dolomite to replace magnesite used for furnace linings. The shortage in the supply of magnesite has been responsible to a certain extent for this development.

A still further and very important development is now going on which will, when it attains its growth, require more pulverized coal than porbably all of the other industries combined, and that is in its application to locomotives, particularly in the West. This application is now being developed.

There is still another field in which enormous quantities of this fuel will be used and a field in which we are all concerned, and that is in the generation of power in stationary power houses.

There are quite a number of installations now in successful operation using in the neighborhood of one hundred to two hundred thousand tons of pulverized coal annually, and the success obtained by these plants has created so much interest and has brought out so strongly the desirability of the use of this fuel for power purposes, that today there are a number of new installations being made by engineers of national repute.

The peculiar conditions as they exist today on account of the war and for other reasons, the gradual reduction of the supply of fuel such as natural gas and the shortage in supply of crude oils which have become of too much value to be used for ordinary fuel purposes, have compelled those interested to carefully investigate the possibility of the adoption of pulverized coal to replace their present expensive methods of operation and high cost of fuel.

Practically any coal can be burned in pulverized form with a proper furnace and burning equipment. Each application, however, must necessarily be governed by the quality of the fuel available in the district in which it is made. Generally speaking, however, the coals which would give the most satisfactory results would be those in which the ash content would be less than 10 per cent the volatile averaging between 30 and 40 per cent and the fixed carbon between 40 and 50 per cent. The sulphur content should be low, although coal with a sulphur content running as high as 4½ to 5 per cent is being satisfactorily burned in pulverized form under boilers. The ash should have a high melting point. These statements, however, are tentative as most excellent results have been obtained from all sorts of coals differing widely from the ideal analysis stated.

It is apparent that the development in this method of burning coal has brought coals from which heretofore very inefficient results have been obtained within reach of a great many consumers. For instance, from Texas to Edmonton, Alberta, the country is underlaid with various grades of lignites, low grade mineral coals with high moisture content and of such a nature that the ash would melt or flow down on the greates thereby preventing the highest efficiency from being obtained. They are of such a nature that their use in gas producers is not very satisfactory, so that until the development and burning of these coals in pulverized form was an assured success these coals were not used in as large quantities as is now possible.

The largest deposits of lignite and mineral coals appear to be in the Northwest awaiting future development when proper means are at hand for obtaining the highest possible economy from their combustion, and the location of these large deposits will now be of great value to the districts in which they are located.

Around steel plants there are large quantities of waste fuel such as coke breeze. This fuel is being used to a certain extent on some forms of grates, with forced draft, but it can be burned in pulverized form under boilers for the generating of power and possibly in the open-hearth furnaces for making steel.

In the anthracite field there are large quantities of coal daily pumped back into the mines as a result of the washing and crushing operation for bringing the coal to commercial sizes. This silt or washery waste coal carries as high heat value normally as the coals which have been operated upon. The president of one of the large coal companies here in the east told me that in the neighborhood of eight to ten million tons annually of this silt was allowed to be pumped back into the mines to fill up old workings.

Pulverized anthracite coal is now being burned in one or two installations, and the writer has personally burned pulverized anthracite coal in a special form of furnace.

PREPARING AND HANDLING OF PULVERIZED COAL

The coal as received is either in the form of slack, lump or run-of-mine, and as it comes to the pulverizing plant it should be crushed so that it will go thorugh approximately a 1-inch ring. A single roll coal crusher of approved make is usually the equipment. The coal should then be dried at low temperature to eliminate the moisture. Ordinarily it should be dried so it will not contain more than 1 per cent of moisture. A low moisture content in the pulverized coal as fired in metallurgical or other furnaces leads to uniform temperature conditions which are highly desirable. This condition is also necessary in order to obtain a product of the highest quality; the highest efficiency is also obtained with dry coal.

The drier is usually of the rotary type; that is, the coal is fed into an inclined shell mounted on rollers and is gradually passed through the drier by gravity. The firing chamber is usually located under the shell or is so arranged that the products of combustion from the drier can be used not only to heat the shell of the drier but also to pass through it in order to obtain the greatest economy from the coal burned for the purpose of drying the coal.

The drier should be so arranged that the gases of combustion coming from the furnace do not come in contact with the coal being dried until they are reduced in temperature so they will not ignite the coal. The temperature of the coal being dried should only be sufficient to drive off the moisture; if the coal is allowed to become too hot, the volatile contents may be reduced, thereby sacrificing some of the heat value of the coal. This condition is very readily obtainable, as practice has shown. A pyrometer should be installed to indicate to the operator the temperature to which the coal being dried is exposed. An evaporation of from 5 to 7 pounds of moisture from the coal being dried can be readily obtained per pound of coal burned on the grates in the drier. The amount of evaporation, however, naturally depends upon the quality of the coal being handled in the driers. The driers can also be fired with pulverized coal if desired.

A magnetic separator of some standard make is installed either before the crusher or after the drier so as to remove what may be called tramp iron which consists of pick points, railroad spikes, coupling pins, links, hammer heads, sledges, tobacco cans, nails, etc., all of which have been accumulated, either from the mines or in the crushing operation at the mines. The amount of iron per ton will vary in certain districts, but it is an item of such importance that magnetic separators are being installed in every first class pulverized coal plant which is now being erected. The elimination of this iron naturally improves the pulverizing and conveying operation and prevents breaks and losses due to intermittent operation and wear and tear of the machinery.

Coal as it is passed through a modern pulverizing plant should be elevated and conveyed in dust-tight equipment. After crushing, the coal should be elevated to bins above the driers. These bins should be of ample capacity and arranged with variable speed feeding mechanism so that the driers at all times will have uniform feed. This is very important so that the moisture content will be reduced uniformly and thereby allow close furnace regulation where the fuel is burned. Leaving the direr the coal is elevated and discharged into storage bins above the pulverizers. The storage bins above the pulverizers should be of such capacity that the pulverizing machinery will at all times receive ample feed to prevent them from running empty. All storage bins should be of dust-tight construction, and equipped with deep hopper bottoms so that the coal is constantly in motion while being drawn off. It is in coal lying dormant or stationary that spontaneous combustion or smouldering action is generated, particularly so where coals are under pressure.

The danger of spontaneous combustion of pulverized coal has been greatly exaggerated. It has been considered that the matter of pulverization increases this danger, but it is a matter of fact that practically nothing more than the usual ordinary precautions taken with all fuels are necessary to guard against it. The mere factor of pulverization is not of any unusual importance as is readily shown in the commercial production of lamp black, which is handled very much like pulverized coal, without bad results. This lamp black is probably 30 to 50 times finer than the average size particles found in commercial pulverized coal. In the lamp black industry, it has been found that only partially filling the barrels when shipping gave much better results than when packing the material up to the top.

Spontaneous combustion is simply the absorption of oxygen. If this absorption becomes too rapid heat will be generated and incandescent combustion will result. The presence of pyrites tends to oxidation to a rapid extent in any fuel, with the probable disengagement of light carbureted hydrogen, and spontaneous combustion results. In the case of lamp black this condition of course is removed as the lamp black contains practically no sulphur, certainly not in the form of pyrites.

Pulverizers of ample capacity to take care of the fuel requirements should be of such a nature that their cost of operation, attendance, power and repairs are of a minimum. A first class pulverizer should be one which

* From a paper read before the Cleveland Engineering Society, and republished from the Journal of the Society.

can operate if necessary over a period of from one to three months continuously without shutting down even for oiling. The pulverizers should also be of a type that normally delivers a product containing the highest percentage of impalpable powder. Coal should be pulverized so that ordinarily 95 per cent will pass a 100-mesh sieve. The machinery in the pulverized coal plant where possible should be driven by electric motor. The drives should be standardized and the motors interchangeable. Backgeared motors are successfully used in a great many installations, and the pulverizers can be driven either by motors with belt drives or gear driven with a flexible coupling between motor and pulverizer.

Dust collectors are sometimes installed in connection connection with driers. This dust is formed by the action of the coal passing through the drier, as the coal falls down a certain amount is ground to dust and this dust, being in suspension, is carried along by the air currents through the drier and the dust collector will recover it.

The adoption of pulverized coal for any particular operation naturally depends on the cost of preparation or handling which is a charge in addition to the fuel itself, which charge, however, in a great many cases is less than that where lump coal is used. The power required in a first class pulverized coal plant per net ton of coal handled is in the neighborhood of 17 horse-power hours per ton produced. This includes the power for crushing, drying, elevating and conveying and delivering the pulverized coal to the conveyors leading to the point of use. The repairs vary slightly with the quality of the coal being handled, but generally speaking the repair costs for the pulverizing plant should be somewhere between 5 and 7 cents per net ton of coal handled.

The drier fuel is practically a constant, as the amount required per ton of coal dried with a given moisture content with standard driers will not vary much.

In the Lehigh Valley district where the coals carry from 5 to 10 per cent of moisture as received, 25 to 35 pounds of coal are required to be burned on the grates per ton of coal dried. The cost of this coal is naturally based on the cost of the coal as received. The great variable in the cost of preparation in pulverizing coal then comes down to the labor item. The labor varies indirectly with the quantity of coal handled and the time or continuity of operation in the pulverizing plant. In other words, the question of labor cost is one directly affected by the equipment installed. One man can handle quite a number of machines, so that in making up an estimate on the probable cost of pulverizing coal careful consideration should be given to these statements.

Generally speaking coal in fairly large quantities from 50 to 100 tons and upwards can be pulverized and delivered to the furnaces at a cost of from 20 to 50 cents per ton depending upon the quantity handled. Nothing nas been said, however, as to interest and depreciation, taxes, overhead and other burdens entering into the ultimate cost of preparation, as these are items which have to be considered in each specific case. For instance, the cost of a pulverizing plant, if it is to be operated 10 or 12 hours per day would be considerably greater than an installation to turn out the same production in 24 hours. The cost of preparation will vary also with the investment, for a given production done in one shift will naturally be accomplished at less cost than if it would require two of three shifts.

To make a positive statement as to the cost of any given size pulverized coal plant today is rather difficult, in that the conditions governing every installation vary. Generally speaking, however, an ideal plant with a capacity of 100 tons of pulverized coal daily will cost with the present prevailing high prices in the neighborhood of from $300 to $400 per ton of coal pulverized. The cost of a plant for 250 tons daily capacity of pulverized coal will be from $250 to $300 per ton. These are just general statements, however, so as to give some idea as to the cost of pulverized coal plants. Information on this subject can be readily obtained from those familiar with the matter.

To the cost of the pulverizing plant there must naturally be added the cost of the conveying system to the furnaces, also the storage bins, burners, etc., as well as the air supply.

When making comparisons between different methods for burning coal, and in order to be fair and just, the cost of each equipment should be considered from the time the coal is received on the track until it is delivered into the furnace. The storage of the raw coal is a condition always necessary; the conveying and handling of this coal from storage to the plant is also a necessity. The handling of any coal at furnaces particularly with boilers requires the installation of bins and spouts. These items are the same whether stokers or pulverized coal is used for firing. The cost of preparation of pulverized coal as stated above would sometimes lead one to believe that the cost is excessive and that it is a cost due entirely to the pulverizing of the coal, but the cost of preparation as outlined above includes items which are common to any system of mechanical firing. For instance, the distribution of coal in certain plants requires hand labor, so in each case a careful study should be made of the conditions governing the installation, the cost of the present operation, and the cost of pulverized coal installation and its costs of operation, before arriving at a decision as to the advantage of one system over another.

The subject of pulverized coal handling from the pulverizers to the point of use is also important. The application of any particular method depends upon the distance to which coal must be transported as well as the quantity to be handled per hour. The general practice in plants where pulverized coal has been used for a number of years and in plants where the capacity would be from about 50 tons per day upwards is the use of screw conveyors for conveying the coal. These screw or spiral conveyors are mounted in dust tight troughs. The gudgeon forming the connection between the different sections of the conveyor runs in chilled bearings and when properly installed its upkeep is very low. They do not require much attention, and the bearings last for years, the coal itself acting as a sort of lubricant. Coal after being pulverized only weighs from 32 to 38 pounds per cubic foot and is permeated with air flowing along the conveyors like a fluid. The horse-power consumption for distribution with this system is the lowest of any, and when properly installed this system is dustless.

There are other means of conveying pulverized coal, such as carrying the coal in suspension. More power, however is required for furnishing air to carry the coal in suspension and at such a velocity to prevent its building up in the blast pipes, than is used where screw conveyors are installed. The necessity of closing up every leak and the possibility of moisture affecting accumulations in the transmission lines make a system of this kind usually expensive to operate.

Another method now being developed is the conveying of pulverized coal through pipes by means of compressed air; with this system the coal enters the pipes in charges, compressed air being used as a means of propulsion. Relief valves and cyclone collectors naturally must be installed so as to relieve the pressure after the charge has been delivered to the receiving point. This system is installed in one or two plants, but its success and operation have not been sufficiently apparent to warrant its installation in plants where a fairly large quantity of coal is handled daily, or for a short distance. This method should be considered where coal is to be transported a long distance.

In connection with tests made on furnaces arranged for pulverized coal at the Calumet Steel Company, the furnace operating in connection with 8-inch mill, the following data are of interest: The scrap material running all the way from small rails 2 feet in length up to 2-inch billets 6 feet long totalling 25,000 pounds daily, being heated, shows that by the application of pulverized coal (the coal being at $2.65 per net ton) as compared with oil at 3 cents per gallon, a saving in fuel of 49 per cent, or $11.75 per day, was obtained. In addition it was found that the average scale, when oil was used for firing, amounted to at least 5 per cent, whereas when pulverized coal was used, there was at least 2 per cent reduction. This 2 per cent reduction showed a daily saving of over $15 making the total daily saving by the application of pulverized fuel burning equipment $26.73 and for the year a saving of $6,019 on this furnace alone.

At the Atlantic Steel Company, there is an installation of a 50-ton open-hearth steel furnace which has now been in operation since November, 1915. They have been averaging around 400 pounds of coal per ton of steel tapped from a cold charge. This fuel consumption shows the possibly of what may be accomplished in connection with open-hearth furnace practice.

It is evident that there are certain conditions which must be met where pulverized coal is fired in open-hearth furnaces heretofore fired by means of producer gas or oil, they require some changes in the conformation of the flues and neck, the installation of removable slag pockets and rearrangement of the regenerating eliminating a certain amount of the checkers and replacing them by means of baffle walls. The cross sectional area of the flues of furnace and checkers itself must be proportioned properly so that excessive velocity of the gases is not permitted.

The Lackawanna Steel Company has been nodulizing flue dust in an 8x125-foot rotary kiln. Pulverized coal is used for heating up the kiln and for the ignition flame and it was found that after starting there was a sufficient quantity of carbon in the shape of coke breeze mixed with the flue dust to support combustion after being thoroughly ignited and that the kiln operated continuously without the necessity of the ignition or pulverized coal flame at the burning end. I just mention this operation to point out that here appears to be an opportunity for making recovery of a by-product at a reasonable cost.

At the railway shops of the Missouri, Kansas & Texas R. R. for over a year pulverized coal has been in use under their boilers with very satisfactory results. These boilers have been operating continuously day and night and for short periods daily at from 150 to 180 per cent rating. Practically no repairs to furnace arches or walls have been made during the the year's operation. Absolutely smokeless operation has been accomplished. The flue gas analysis during some of the recent tests has varied from 15 to 17 per cent CO_2. Coals carrying on an average of from 10 to 22 per cent of ash with a moisture content varying up to 17 per cent as fired are being burned satisfactorily. The furnace efficiency has been very nearly perfect; three tests made in June showed a furnace efficiency of 98.4 per cent, 98.6 per cent and 99.4 per cent.

The pulverizing action increases the superficial area of the coal thereby rendering its combustion far easier of accomplishment and more complete, since each minute particle will be surrounded by sufficient air to insure its combustion. It is evident also that the more finely divided the coal is the more readily it can be satisfactorily burned, and under proper conditions it is absolutely smokeless.

Summing up the whole subject, it may be seen that the use of pulverized coal has no insuperable difficulties to be overcome, but merely those which have always hampered the introduction of new methods. Pulverized coal is here to stay, for it is very closely allied to the conservation of our natural resources.

Metal Coloring

Shakudo is an alloy consisting essentially of copper and gold, which is used in Japan for the manufacture of objects of art and is colored by treatment with aqueous solutions containing copper sulphate and acetate. The author's experiments show that the coloration is due to the production of a layer of cupric oxide, the tint being determined by the thickness of the layer. The coloring-solution contains hydrogen ions owing to hydrolysis of the copper salt, and when the alloy is introduced a local electrical circuit is formed between the gold and copper, the latter being dissolved as cupric ion and hydrogen ions being discharged, thus disturbing the equilibrium. In consequence of this, hydrolysis proceeds further, and the process goes on, with progressive increase of the concentration of cupric and hydroxyl ions, until the solubility product of cupric hydroxide is exceeded. The precipitated hydroxide is rapidly converted into the oxide, which is deposited on the surface of the alloy. An analogous coloration can be obtained on alloys containing palladium, platinum, and silver, respectively, in place of gold.

In confirmation of these views as to the mechanism of the coloration of shakudo, it is shown that a similar effect is produced by mere contact of copper with platinum, palladium, or gold in the solution used, and that an electric current is produced when a copper electrode is connected by a copper wire with a platinum or palladium electrode immersed in acid or in the salt solution used for coloring shakudo. The coloring of "shibuichi," an alloy of 25 per cent of silver and 75 per cent of copper, used for purposes similar to those mentioned for shakudo, is due to an analogous cause.—*Note in Journal of the Society of Chemical Industry* on an article by S. Miyasawa in *Journal of Chemical Industry*, Tokyo.

The Local Gods of Egypt

The question of the character and origin of the local gods of Egypt is still obscure; but a paper by Prof. Flinders Petrie, published in *Ancient Egypt*, part iii., 1917, does much to clear it up. Prof. Petrie has collected the original records of these cults, and by marking the headquarters of each deity he arrives at important results. Ra appears in only one southern city, and his cult seems to have come from the north-east. The distribution of Mut, the mother-goddess, is decidedly eastern, while that of Amen is western. Set was certainly brought into Egypt by the desert road, as he had there two centers of the first class, and he was introduced by the Red Sea way to the Eastern Delta. The distribution of the Osiride triad indicates a settlement so early in the land that the worship was generally diffused. Prof. Petrie sums up his article thus: "The geography of the worship of the gods is thus seen to have a considerable value historically, as bearing on their origin and connections. When more complete research into the localities of various uncertain names may extend our identifications, it will be possible to get more light on the sources of Egyptian mythology."—*Nature.*

Adult male emu and young. The chicks are about three weeks old. The smallest bird was released from the shell by the keeper

The birds grow rapidly. Here are the young emu, shown on the left, as they appear when at the age of three months

The Emu in Captivity*

Peculiar Habits That Make Breeding Difficult

By Lee S. Crandall

When our devoted male emu first became a father, his inexperience in rearing emus was equalled by our own. Young parents are proverbially foolish, and when a mother with advanced ideas refuses to accept the responsibility of caring for her offspring, a domestic calamity threatens.

But feminine slackers are quite the usual thing in emu families. Ages before the first lady of our own race conceived the idea that she was much too busy to be bothered with the care of babies, Mrs. Emu had turned over to her mate the drudgery of the nursery. She felt that the production of eight or nine delicately-tinted green eggs, artistically etched over with a darker shade, was burden enough for one who wished to be more than a mere household slave.

In Australia, emus at liberty breed from April to November. Just why our birds should decide that, in New York, January offered the most suitable conditions, still is a mystery.[1] At any rate, our first emu egg appeared on a frosty morning early in 1915. Its advent caused little excitement in the emu colony. The prospective father appeared unsuspicious of impending fate. The mother was indifferent concerning the future. Their combined intelligences were unequal to the task of protecting the egg from frost, and instinct had had no experience with such an emergency. The egg froze and burst.

Birds are actuated chiefly by instinct. Since this influence, unaided, seemed insufficient to cope with 10° Fahrenheit, reason, in the form of a rounded stone coated with green paint, came to its assistance. The female emu was persistently watched by her keepers and the instant the next egg appeared, the stone was substituted for it. Not that it really mattered, for neither bird was at all interested.

By this means, six perfect eggs were accumulated. When instinct suddenly convinced the male that nothing could be more attractive than reclining on a bed formed of three large, hard stones, the six eggs were entrusted to his care. As already recorded,[2] after many difficulties caused by the untried state of all the principals, one baby bird was safely hatched and finally reared.

After this successful experience, we all felt that emu broods would become a matter of yearly routine. But we had planned without proper consideration of father-love. The emu was fond of his chick. There could be no doubt of that. So deep was the mutual attachment that neither bird could endure life beyond the sight of the other. As autumn approached, we viewed the strength of this feeling with some misgivings, for the period of courtship was approaching, and there was no indication that filial affection would tolerate encroachment.

In November, it became evident that father and son must be separated if the mother was to be restored to her rightful position. The chick, now well grown, was driven into an adjoining corral, separated by a wire fence. An emu's method of combatting material obstacles is to kick hard. A wire fence is a dangerous antagonist, because it is too springy to be affected by a blow, but is very likely to enmesh the trip-hammer feet. The distress of both birds took such a violent form that only a quick reunion prevented damage to property and limbs.

But, however distressing it might be, the family bond had to be severed. After a struggle, the young bird was seized and carried bodily to a large stall inside the Yak Shelter. Here were only smooth, discouraging walls to kick against, and the prisoner soon became reconciled.

In spite of our well-meant efforts, a connubial reconciliation did not take place. The male finally came to tolerate his erstwhile mate, but that was all. Autumn chilled to winter, and with the coming of spring, the young bird emerged from his indoor imprisonment and rejoined his parents. He was now nearly as large as they, and distinguishable only by the practiced eye.

Early in the next winter, there were evidences of renewed affection between the old pair. In February, 1917, matters had so well progressed that a frozen egg was found one morning in a corner of the corral. Now came a demonstration of the value of experience. A stone egg was quickly produced and placed on the floor of the indoor shelter. The bird showed the deepest interest in the substituted egg, and covered it carefully with straw and debris, which was rearranged daily. The indifference of callow youth had been replaced by the solicitude of maturity. Our emu had become a professional father.

The female was, if possible, even more irresponsible than ever. Her eggs were deposited in every corner of the enclosure, at intervals varying from four days to a week. Only the vigilance of her keeper prevented the loss of every one. As each egg was laid, a wooden or stone imitation was placed in the shelter. Here they were received, covered and duly inspected in good faith by the male.

After six had accumulated, the bird became broody and spent much of his time in sitting about on the ground. He continued to look after the eggs, but made no effort to begin incubation.

Two vestibules lead to the inner room occupied in winter by the emus. We had wished the bird to make his nest in the smaller one, for its dimensions were more suitable for arranging the nest. But the vagaries of instinct again became evident. The bird refused to brood there. A lovely nest of fresh, green sod, occupied by five attractive dummy eggs, could not lure him. He often peeked in at the door of the proposed nursery, but although the eggs had been there from the first, he now refused to enter.

Fearing that the fatherly impulse might pass, we removed the nest from the first vestibule to the one of the bird's choice. It evidently accorded with his notion, for he lost no time in taking up his eight weeks' vigil.

Three eggs, perhaps frosted, later had to be removed, but eventually three beautifully-striped chicks appeared. The third had difficulty in extricating itself, and was saved by the efficiency of the keeper. The young birds have grown beyond expectation, and are much brighter and more active than the one of two years ago. Perhaps it is not surprising, for their father is now a model foster mother.

*From the *Bulletin* of the New York Zoological Society.

[1] In Australia the summer month of January is the equivalent of our July. M. G.

[2] *Bulletin*, Vol. XVIII, No. 5, September, 1915.

Increasing T.N.T. Supplies

One of the surprises of the present war has been the great explosive power of tri-nitro-toluene, better known under its abbreviated form of T. N. T. The explosive used in the Boer War was principally lyddite, and the basis of this and many other similar explosives was, or perhaps we should say is, for it is probably still in use, picric acid. T. N. T. is the next step upwards in the same chemical series. The power of the modern torpedo, which has had so great an effect upon naval tactics is due to T. N. T., and probably much of the high explosives used to pulverize trenches and dugouts and create the great shell-craters consists of the same substance. Practically the only commercial source of benzol and toluol, from which lyddite and T. N. T. are made, is coal tar oil; and, as a consequence, all the gasworks in the kingdom have been doing their utmost to obtain as much as possible of this substance for the Minister of Munitions. The demand, however, has exceeded the supply, and, accordingly, attention has been directed to coal-gas itself, the illuminating properties of which, when burnt in a flat-flame burner, are due almost entirely to small quantities of benzol and toluol contained in the gas.

Up to the present only a comparatively small proportion—much less than half—has been recovered. The description by Dr. R. Lessing at a recent meeting of the Society of Chemical Industry, of a process for the complete recovery of the benzol and toluol in coal gas, by means of which it will be possible to obtain about two gallons of benzol and a tenth of that quantity of toluol from every 10,000 cubic feet of gas, is particularly opportune. This is a discovery which will prove as useful in peace as in war, for benzol and toluol form the basis of most of our coal-tar colors, and will prove invaluable to our rapidly-growing dye industry, which is making gigantic strides towards filling the place formerly occupied by the German dye works. Further, we have here a prolific source of home-produced fuel for our internal-combustion engines.

Benzol, before the war, was coming rapidly into favor for driving these engines, though only about one-tenth as much benzol was used as petrol. After the war we ought to be producing in this country at least five times as much bensol as in 1914. Such a supply should mean the freeing of a very large amount of tonnage—and tonnage will be scarce for a long time after peace is declared. In fact, the whole of the petrol previously imported could be done without by us if the home-produced fuel-alcohol question were properly tackled. There is good reason to suppose that the new Board of Fuel Research will give particular attention to the future of alcohol as a fuel. It has been estimated that fuel alcohol could be produced for 3d per gallon. Mixed with an equal quantity of benzol we have an ideal fuel that can be used without engine alteration.—*London Daily Telegraph.*

Fumigation as a Disinfecting Agency*

By C. T. Kingzett, F.I.C., F.C.S., H. F. Bottomley, F.C.S., and J. E. Brimley, B.Sc.

In a leading medical journal published in the United States of America (*Boston Medical and Surgical Journal* March 9, 1916) will be found an account of certain experiments made by Dr. W. W. Walcott (State District Health Officer of Massachusetts), in conjunction with Dr. Curtis, from which it was concluded that fumigation is useless for the purpose of disinfection; but as this conclusion was directly opposed to our views based upon previous experimental work of our own and others, we resolved to make the subject one of further exact investigation. For this purpose a chamber of 1,018 cubic feet capacity, made of brickwork, lined internally with white porcelain tiles (so that it could be easily washed and cleansed), was specially constructed, having one window opening from the outside (in order to allow the gaseous contents to escape at the end of each experiment), and two doors forming a lobby entrance, so that the apartment could be easily entered and thoroughly sealed.

Immediately before the testings a twenty-four hours' broth culture of *B. Typhosus* of good strain was absorbed by strips of sterilized filter-paper (1 inch by ½ inch), and these moist unwrapped strips were placed in open Petri dishes in several parts of the chamber—(*a*) on the floor, (*b*) on a table four feet above the floor, and (*c*) on the top of a compartment six feet four inches high. Other strips similarly soaked were done up in fine muslin, nine inches by three inches, wrapped round three times (so that they were wholly enclosed), and laid on open Petri dishes in the same situations. They were then exposed to various fumigations, as will be described, and at the conclusion of each experiment transferred to sterilized broth contained in tubes and incubated for at least seventy-two hours at 37° C. All the growths, where any, gave the characteristic appearance of *B. Typhosus*.

Many series of experiments made over the last 15 months have been conducted and repeated at different times of the year, using fumigations of:

1. Formaldehyde, as generated by the volatilization of paraform in the form of tablets, and using the direct heat of a wax night-light.
2. Formaldehyde, as generated by the evaporation of a 40 per cent solution of that liquid, using the direct heat of a wax night-light.
3. Formaldehyde, as generated by the action of permanganate of potassium upon a 40 per cent solution of formaldehyde.
4. Mixed vapors of sulphur dioxide and formaldehyde, as generated by several appliances in which the burning sulphur was made to generate the formaldehyde vapor from solid paraform and 40 per cent liquid formaldehyde respectively.
5. Vapor of sulphur dioxide, as generated from burning sulphur candles.
6. Sulphur dioxide vapor, generated as in 5, but in association with aqueous vapor, the burning sulphur being utilized to vaporize the water contained in a surrounding jacket.

The results so obtained varied within certain limitations with the special construction of the several appliances used, and to some extent doubtless with the temperature of the fumigating chamber and the humidity of the air; but they were, all the same, very definite and precise in character, and may be summarized as follows:

First, as regards paraform and formaldehyde vapors, it may be said that no matter how generated, similar quantities were found to exercise the same destructive action, and it was ascertained that this action was neither accelerated nor increased by association with aqueous vapor.

No advantage whatever was presented by the employment of formaldehyde solution as compared with dry paraform, and, on the other hand, a slight disadvantage was experienced by the use of the permanganate method, as this necessarily causes the chemical destruction of a portion of the formaldehyde itself.

The use of 20 grms. of paraform, or an equivalent amount of formaldehyde liquid—that is, 1¾ ounces of the 40 per cent solution—invariably destroyed the unwrapped and wrapped cultures within a period of two hours in a space of 1,018 cubic feet. Seventeen grms. of paraform was the actual *minimum* quantity found to be effective.

With the permanganate appliance it was found necessary to use two ounces of the 40 per cent formaldehyde and ¾ ounce of the permanganate as a minimum to effect the disinfection within the two hours' period.

As to the mixed vapors of sulphur dioxide and formaldehyde, it made no difference whether paraform or 40 per cent solution of formaldehyde was used as the source of the formaldehyde vapor, and it was found that with the special apparatus which we employed, complete disinfection was effected within two hours of both the unwrapped and wrapped cultures, using either:

(1) 2¾ ounces sulphur and 11 grms. of paraform, or
(2) 2½ ounces sulphur and 11½ grms. formaldehyde as generated from 1 fl. oz. of the 40 per cent solution.

A great number of experiments had to be made before these—the best results—were obtained. As already noted, they were found to depend to some extent upon the temperature of the atmosphere and its humidity, and more considerably upon the particular construction of the apparatus, which, in its most effective form, was designed to burn the sulphur as quickly as possible, and to generate in this way sufficient heat to cause the thorough vaporization of the formaldehyde.

It is obvious from the results that the combination of the two gases (sulphur dioxide and formaldehyde vapor) presents, or may present, advantages in certain cases, namely, those in which there are more highly-developed organisms in addition to bacteria which it may be desirable to destroy at the same time, such as moths, fleas, and bugs.

With sulphur candles the use of water-vapor as generated simultaneously with the sulphur dioxide, proved, as was to be expected from our previous experiments, very helpful, and it was found necessary to use as a minimum nine ounces of sulphur in association with six ounces of water to secure thorough disinfection within two hours of both the unwrapped and wrapped cultures. Without the joint use of water-vapor, as much as 16 ounces of sulphur was required as the minimum, and a longer period of exposure (five to six hours).

Here, again, of course, the results were variable to some extent, being largely dependent upon the particular construction of the apparatus; but the recorded results were the best actually and repeatedly obtained at different times of the year and at atmospheric temperatures ranging from 38° to 80° F. It should be noted that in many cases it was found that the unwrapped cultures were destroyed some time before the wrapped ones. In practice, however, it proved desirable to work upon a two hours' exposure standard, and the results have been standardized upon that basis. In all cases there were control cultures, and in every case these were found to be actively alive after 72 hours.

It is not difficult to understand how Dr. Walcott and his associate arrived at their conclusions, as in their experience whenever they found that fumigation had destroyed the germs with which they experimented, the control cultures were also found to be dead. It may be observed that instead of making use of laboratory cultures, "because of the possibility of their being attenuated," they used as their materials "smears and swabs from noses, throats, and ears," from contagious wards and from "suppurating wounds." Why, then, it may be asked, were the control cultures found to be dead after certain exposures without fumigation? We entertain no doubt that the "smears and swabs" were too insignificant in amount, and that consequently desiccation, causing starvation, destroyed the germs in all cases. Moreover, such materials should not be employed, bearing in mind that disinfection of this sort is in no way concerned with infected persons, but only with infectious material, of which they are the source; and, as was pointed out by Dr. Kenwood many years ago—("The Disinfection of Rooms," by Henry Kenwood, M.B., D.Ph.; a paper read at a Congress of the Sanitary Institute, held at Leeds, 1897)—in ordinary practice we probably have to deal with non-spore-bearing bacteria and of comparatively easy destructibility, and these bacteria do not find at their site of lodgment anything approaching the fostering and protective properties of the nutrient media, in which they are planted in experiments. It is interesting also to note that Dr. Kenwood reported at the same time that the evidence furnished by a population of over a quarter of a million had proved that sulphur dioxide disinfection of rooms very rarely breaks down in practice.

On another occasion—(In the discussion of a paper read at the Bristol Medical Assoc., Edinburgh, July 29, 1898, by Dr. F. J. Allan and Cecil H. Cribb, B.Sc., F.I.C.)—he reported that while he had found ten paraform tablets to each 1,000 cubic feet of space unreliable, it was necessary to use about twenty-five tablets to each 1,000 cubic feet to ensure disinfection—an experience in good practical accord with the results of our more recent investigation, which it will be observed has been conducted upon strictly quantitative lines.

We agree with Dr. Kenwood that in respect of the ordinary infectious diseases, the infections to be dealt with are easily destroyed under the circumstances of their existence apart from the human body, nor have we any hesitation in concluding that fumigation with formaldehyde or sulphur dioxide, as described in our experiments, secures absolutely effectual disinfection to the extent that is sought by Medical Officers of Health in dealing with rooms that have been occupied by infectious cases.

Our investigation establishes the non-necessity of employing complicated apparatus for the generation of formaldehyde vapor under pressure, and the equal efficacy of paraform, which can be used with more convenience in practice. It also as clearly reestablishes the efficacy of disinfection with sulphur dioxide gas, particularly when generated in association with aqueous vapor.

* *The Chemical News.*

A portion of the emu flock at the New York zoological park. Their peaceful appearance here is not a true index of their normal state

Protective Treatment Against Typhoid in the French Armies

A very remarkable statement was made to the Paris Academy of Sciences on October 1st by Prof. H. Vincent, who is director of the great Army Laboratory at Val-de-Grâce, one of the most beneficent institutions of France. He was responsible, in the early months of 1915 and afterwards, for the arrangements in the French Army for the protective treatment against typhoid. He gives the results in a short note with a graphic diagram. He contrasts the terrible havoc wrought in previous wars with the almost negligible death-rate from typhoid in the present war. A heavy incidence of typhoid began in November, 1914; it became much less during March-April, 1915. During this period, November, 1914,-April, 1915, the protective treatment could not be effectively carried out at the front, because of the necessities of the war. From April, 1915, onward—except for one very small rise in the summer of 1915, due mostly to paratyphoid fever—the death-rate has been kept almost at *nil*. The line runs steadily along the bottom of the diagram, as one loves to see it. From August, 1915, onward the French Army has received protective treatment, not only against typhoid fever, but also against those two forms of paratyphoid fever which at present are called paratyphoid A and paratyphoid B. The results are magnificent. As Prof. Vincent says: "For more than two years the French Army at the front has enjoyed a very remarkable state of sanitation; typhoid and the paratyphoid fevers no longer show themselves, save at a very low degree of frequency. And this, though all the conditions at the front are united to favor the outbreak, spread, and gravity of these diseases. Immense masses of men crowded at close quarters, in such number as one has never seen the like of in any war; incessant renewal of effectives; a long war, and almost ceaseless engagements; near contact of troops, and constant risk of infection from man to man, from patients or from germ-carriers; formidable and continuous contamination of the surface soil by the excreta of germ-carriers; breeding of flies, etc." Yet, in spite of it all, "these diseases may be considered as practically conquered." It is strange to think that one of our "anti-vivisection" societies has been trying to prevent the protection of our own men. Happily, it has failed; the latest returns show that 98 per cent of them are protected.—*Nature.*

Some Points in Photo-Copying

To copy "prints" and engravings satisfactorily it is well to know something of the nature of the originals. Engravings, and what a dealer calls "prints" are usually engravings of some kind, may be divided into those printed like type, and those which are intaglio printed. Wood cuts and wood engravings are printed like type that is the raised parts of the block receive the ink from the roller and transfer it to the paper. The blocks resemble, in fact, a rubber stamp. Such prints are absolute black and white, and the tones of the picture are obtained by the width of the lines and their closeness together. Intaglio plates, on the other hand, are of metal, steel or copper, and have lines or holes cut, or etched, into their surface. Some of these lines or holes are deep and broad, others shallow and fine. The plate is covered with a thick greasy ink, which fills all the lines, and the ink is then wiped off the surface of the plate in various ways, sometimes completely, sometimes incompletely, but always in such a way as to leave the lines or holes full of ink. Damped paper of a proper quality is then placed in contact with the plate, and the two are passed through a copperplate press. The paper picks out all the ink from the lines, etc., and the "impression" is thus obtained.

Now note that if the surface of the plate is wiped clean, as in the case of what is commonly called a "steel engraving," we have again clear lines in all the lighter tones and the half tones (these tones being produced by the width and closeness of the lines), but in the deep shadows or dark tones the lines, though usually still distinct, are connected by a tint, really ink which has run out of the deeply-cut or etched lines. All this may be seen with a pocket magnifier on almost any decently good steel engraving. The *effect* may be explained, perhaps, in this way. Make a drawing with the pen on smooth white paper. The image is entirely built up of lines. But it is decided that the shadows are not dark enough, and a little diluted ink is run over them with a brush. The area is darkened though the lines are still visible.

But in etchings this effect is often carried further. Some of Whistler's plates, printed, we believe, by Mortimer Menpes, and printed *cold*, give a clean, delicate, pure line. But most etchings are printed with the copperplate warm, and this warming softens the greasy ink and helps the production of a tint. The plate is seldom wiped clean, and the printer (who must be an artist, in perception at all events) decides which parts will be most cleanly wiped, and where he will leave a good deal of ink to produce tint. Finally, he draws very delicately across the warmed plate a piece of soft butter muslin, and this drags out of the lines a trace of ink, leaving this trace deposited on the surface of the plate between the lines. This is known as *retroussage*. This effect, then, is analogous to the use of a wash of diluted ink on *any* part of the pen-drawing which it is wished to darken or enrich, or which might be improved by tint added to the line, or even washes of varying strength over the whole.

Mezzotints, aquatints, and photogravures are made up of tiny dots of irregular shape and size, the *grain* being so fine that the effect of tint is produced. Lithographs, produced in quite a different way, give tint effects, and are finer still in grain or even grainless, and more like washes of water-colors.

We have given these very elementary details because as far as possible the photographic copy should show the characteristics of the original. Obviously the lines, dots, or grain of a print, 20 by 16, will not be visible in a copy made on a half-plate, but where the scale is the same, or nearly the same, the characteristics should be retained to as great an extent as possible, and to do this the photographer should know approximately what those characteristics are. A table may be handy for reference:

Print	*Characteristics*
Wood engravings / Wood cuts	Lines, crossed in places, sometimes masses, black with white interspaces
Steel engraving	Line or stipple, or both, tint in shadows
Stipple engraving	Irregular dots (prints often hand colored)
Aquatint etching	Irregular grain (prints sometimes colored)
Mezzotint	Irregular grain, showing dots blended by some tint, usually very rich and strong effects
Etching	Lines, usually with tint produced in printing
Dry point etching	Lines, very rich in quality, due to the burr raised by the steel needle or diamond point
Lithograph	Tint, almost if not quite grainless

To secure these dots, lines, etc., in the copy, it is first necessary to focus very carefully and, usually, to employ a small stop. If an R. R. lens is being used this is necesary to get definition at the margins, and many anastigmats have sufficient spherical aberration to prevent their being used for such work at anything like full aperture. An eyepiece should be used in conjunction with the finest acid-etched screen, and the image must be examined in every part, not merely in the centre and edges. Plates must be "process," and if the paper is at all yellow, as it may be without appearing so, an ortho-process plate should be used. Large plates present some difficulty, but better results will be obtained if the plates are desiccated before exposure. For small work an electric hot plate may be used, and for large ones a drying cupboard, if one exists, or can be fitted up, so as to be free of gas fumes. Drying would seem to make film thinner, and so there is less loss of definition through irradiation, and we believe density is more easily obtained

Development presents a difficulty. If the subject is a woodcut the development time is immaterial so long as the black lines remain clear glass and the white spaces are developed opaque enough to print white. But where there are both line and tint, development must be gaged very nicely, and we think trials on the time and temperature method the only safe way.

When dealing with pencil drawings, their soft greyness and delicacy should not be lost sight of. There is some risk of getting too strong a negative on the process plate, though it is probably the best plate to use. But any print which suggests an ink line may be regarded as a failure, for not only is the characteristic of the original lost, but as pencil gives grey tones of varying strength and delicacy, some of the lighter ones are sure to be lost if the development is overdone. We are inclined to think that some slight recording of the texture of the paper is an advantage when anything other than a Bristol board surface has been used for the drawing.

As we hinted in the first article, legal and commercial copying should receive attention. A photograph will often show an erasure about which one cannot feel certain in ordinary examination, and it would be well to make a few experiments in copying writings containing erasures. Much depends on the angle of lighting, and in general the copy should be made on as large a scale as possible, microscopically sharp, and enlarged two or three diameters on smooth or glossy paper.

Copying so as to get rid of some stain in the original has been alluded to. For this we must employ a contrast filter, which may be of any required absorption, or popularly, of any color. Take a white envelope, with a penny stamp attached, into the dark-room. The stamp becomes practically invisible. Why? Because the whole of the envelope is reflecting red light, the color of the stamp. The same effect is obtained if a red filter is laid over the envelope in daylight. A photograph of the envelope taken through the red filter on a panchromatic plate would similarly obliterate the stamp. This is the key to the use of contrast filters for stain removal, the absorptions of stain and filter must agree. A great deal can be done with the tricolor sets, red, green and blue-violet, and a Kiii., but a liquid-filter, which may be modified as required, is an advantage. It must be remembered that if the stain is obliterated in the copy everything else of the same color will be obliterated also. When using a blue filter an ordinary plate may be employed, but in other cases a panchromatic plate is the best unless the stain is a not very deep yellow, when an ortho. is all right. We have referred to a "stain," but obviously the same treatment may be applied to writing in colored ink, and so on. Annotations made in red ink would be lost in the copy exposed through a suitable red filter, just as a red stain would be.

If it is desired to lighten any color in its monochrome translation the same rule may be applied. We have a blue and yellow poster, which photographed on an ordinary plate is recorded with the blue too light and the yellow too dark. Using a blue filter this effect would probably be intensified, the blue might appear as white and the yellow as black. But using an ortho-plate and and a deep yellow filter the blue would appear dark and the yellow probably almost white. The use of a contrast filter in this way must not be confused with color correction. It is an arbitrary control of tones for some specific purpose.—*British Journal of Photography.*

Acid Economy in Metal Industries

In the process of manufacture a large proportion of metal undergoes heating for annealing purposes—in some cases repeatedly. The usually unavoidable presence of air leads to oxidation, a scale of oxide or oxides of varying thickness resulting. The removal of this scale is accomplished by either mechanical or chemical methods the latter involving the use of acids known as "pickles" or "dips." The extent of the industries involved in the production of brass goods and those of tinplate and galvanized sheet will give some idea of the enormous consumption of acid for this purpose. The acids in common use are oil of vitriol, aqua fortis, and muriatic acid. It is safe to say that up to the present the processes have been worked with prodigious waste, due to the scrapping of the acid while containing a fair portion of free acid, in addition to a by no means unimportant metal content. A comparatively few users of acid on a large scale have for some time sought methods of economizing, such methods being much more readily applicable to large scale workings. Economy on the small scale, however, is of a very limited order, and even in large works enormous quantities of acid liquor of high metal content have been and are still turned out into the sea, or, in the case of inland works, into the drains.

It is of interest to note some of the attempts which have been made to recover such acid and to utilize the metal content, and to prospect for future economies. Many years ago Professor Thomas Turner devised and worked on a large scale a method for recovering much of the hydrochloric acid in the acid liquors resulting from the pickling of iron sheets for galvanizing. The spent liquor was continuously trickled on to a fireclay hearth, when the free acid was evaporated and readily recovered by absorption, and a deposit of ferrous chloride obtained. This on further heating in air yielded up its combined acid, leaving a mass of oxide of iron now available as a fettling material.

Where oil of vitriol is used, as in the tinplate industry, the sulphate of iron, or "copperas," may be to some extent recovered, and on calcination yields an oxide of iron in the form of rouge, employed as a polishing material.

For brass and copper goods, diluted oil of vitriol and in some cases this acid mixed with aqua fortis has long been in use. Such acid liquors become charged with the salts of the metals, and are no longer available for use unless additions of new acid are periodically made.

Recently, however, with the further limitations—due to the war—of the acid available, a substitute in the form of nitre cake has been used. This consists of the residue of the manufacture of nitric acid, and contains a large proportion of acid sodium sulphate, with small amounts of other compounds, and with a trace of nitric acid. The large increase in the production of nitric acid has liberated similar large quantities of nitre cake, the use of which in the form of a solution is being encouraged and extended for pickling. Economies in other directions are, however, possible, and should be pursued where available. Thus it is obvious that the pickling process will be simplified if care be taken to limit the the formation of scale, by annealing out of contact of air or in a neutral atmosphere. The method of close annealing which is followed in the tinplate and galvanized sheet industries, and in which large quantities of sheets are annealed in practically closed boxes, would seem to suggest that similar methods might be more largely applied, in addition to which muffles with a more nearly neutral atmosphere could be employed.

Again, in the actual pickling process, it has long been pointed out that a large consumption of metal, and with it acid, correspondingly occurs. Obviously, the problem is that of removing scale with a minimum solution of metal. To effect this, electric or electrolytic methods have been proposed. The scaled metal is made the cathode in a weak acid, much below usual pickling strength. The hydrogen set free on passing the current reduces the scale to metal, thus effecting its removal, and, simultaneously, protecting the metal from attack. Modifications of this method have been in use on the small scale with very satisfactory results, not merely on account of acid economy, but by reason of the effectiveness of the method. While, however, success may attend small scale work in which the time factor is not important, on a larger scale the handling of, say, hundreds of thousands of parts may present mechanical difficulties not easily surmountable. We should, however, rely on the ingenuity of our engineers to overcome these troubles, especially having in mind the extraordinary manner in which small work is handled in bulk in other branches of industry.

The time has surely come when research of a serious nature should be undertaken in this direction, and, to encourage economy among even small users, some organization should be brought about to effect the cooperation which is necessary to eliminate so much waste. —*London Daily Telegraph.*

Glass Vessels and Organic Researches

Messrs. L. Maquenne and E. Demoussy show the important part which is played by glass in making researches in the organic field, for instance in studying the effect of certain substances upon plant cells. It is recognized that various substances will influence the growth of plants even in very minute quantities, therefore glass vessels must be avoided, because water will dissolve a minute amount of the substances in the glass, and these will have an effect upon plants. For instance the active salts dissolved out of glass are alkaline silicates and sulphate of calcium. Sodium and potassium are seen to have scarcely any effect upon germination of peas, for instance, so that this is altogether due to the presence of calcium. The authors find that calcium has here a new function which was not noticed before because the proper precautions to secure pure products had not been taken. Quartz vessels must therefore be used.

The Economical Purchase and Use of Coal for Heating Homes with Special Reference to Conditions in Illinois

SAVE COAL

Coal is scarce and costly. Conservation of fuel is desirable at any time; at present it is obligatory. When you buy a ton of coal you buy the equivalent of so much heat, the exact amount depending upon the character of the coal purchased. In the process of burning, some of the heat units will be utilized to heat the rooms of your house and to maintain a draft; others will be wasted as the result of uncontrolled losses.

The number of heat units you are able to convert into useful heat—the amount of heat you actually receive for your money—depends upon the way in which your heating plant is installed, the characteristics of the fuel you buy, and the degree of attention you give to the operation and regulation of your heater.

SAVE MONEY

To save money on your fuel bills, look over your heating plant to make sure it is in good shape, and give careful attention to the method of firing. The following suggestions will help you:

THE HEATER

If the majority of the rooms of a building are to be heated, use a single furnace, heater, or boiler, requiring one fire and one chimney, instead of a number of stoves with several chimneys.

Make sure the foundation or floor on which the heater is set is true and level, and that air does not leak into the ash pit through cracks at the floor line. Excess air leakage at this point means that the fire will burn out too rapidly even when the ash-pit door and draft dampers are closed.

All fire, ash-pit and clean-out doors opening into flues should be air tight when closed.

Suitable clean-out doors should be provided in all types of heaters for cleaning the interior heating surfaces over which smoke or hot gases pass, and upon which soot or ashes may collect. Failure to keep these surfaces clean leads to fuel waste.

DAMPERS

All classes of heaters should have the following dampers or their equivalent:

Draft damper in ash-pit door for supplying air below the fire to make it burn more rapidly.

Check damper in the smoke connection, just outside of the heater, to admit cold air into the smoke pipe to check the draft (opening the fire door to accomplish this is bad practice as it cools the entire heater).

Cross damper on the heater side of the check damper to control the intensity of the chimney draft when the check damper is closed. This damper usually requires adjustment only a few times during the heating season.

THE FIRE BOX

The amount of heat which can be developed and transmitted to a heat distributing system having a suitable chimney depends directly upon the amount of coal that can be burned in the heater, and this, in turn, depends upon the construction and area of the grate. In order to get more heat it is necessary to burn more coal. It is also necessary to have the fire box or space above the grate large enough to hold not only the coal burned between firing periods, *but also enough extra coal to kindle the next fuel charge* very rapidly. This means that ample fuel-burning and fuel-holding capacity is a most important feature in a heater; otherwise too frequent attention to firing will be required.

THE SMOKE PIPE

The smoke pipe should run as straight as possible from heater to chimney and should have a decided upward slope toward the chimney. It should have a covering of at least 3-ply asbestos paper of which one layer should be corrugated. For best results, this pipe should not exceed 10 or 12 feet in length.

THE HEATING PLANT AS A WHOLE

The chimney flue is probably the most important single item in the heating system, exclusive of the heater. It should run straight up from the basement, without offsets, to a point *at least two feet above the highest part of the building or surrounding objects*, and should be smooth, of uniform cross section, and *air and gas tight*.

The smoke pipe should not project into the base of the chimney so as to obstruct in any way the free area through the chimeny, and there should be no openings into the chimney except the clean-out door at the bottom which should be tight.

COVER PIPES AND DUCTS

All piping for steam and hot-water systems as well as all warm-air ducts for furnace systems should be thoroughly covered with suitable insulating material. This covering should also include the entire heater above the grate line.

For the economical operation of warm-air furnace systems, the furnace should take its air supply from inside the house instead of from out-of-doors. The recirculating duct should be large and practically equal in size to the combined area of the warm-air leaders coming from the furnace.

BUILDING SHOULD BE TIGHT

No system of heating can be economical unless a careful inspection of the building is made, and every precaution taken to prevent the entrance or inleakage of cold air around windows and doors, especially those on the windward sides. Whenever cold air leaks into a house, an equivalent volume of warm air leaks out, and the heating plant must make up this loss in heat.

In frame buildings the outside walls should not only be air tight, but the air spaces between the studs should be completely closed off at the basement and at the attic so that air currents cannot pass up through these spaces.

FUELS AVAILABLE FOR HOUSEHOLD USE

While anthracite, eastern bituminous coals, Pocahontas, and coke are normally available for household use in the central west, present conditions make these fuels costly and difficult to get. The fuel available at present for use in Illinois comes very largely from the mines of Illinois, western Kentucky and Indiana.

Coal is composed of the following materials in varying proportions:

(1) Solid or fixed carbon which burns with glow and without flame.

(2) Gases or volatile products which escape from the coal when it is heated and which burn with a flame.

(3) Gases or volatile matter and water which escape from the coal when it is heated and which do not burn.

(4) Ash or mineral matter which will not burn and which remains as ashes after the coal is burned.

Bituminous or soft coal should be fired frequently in rather small charges in such manner that the gases arising from the fresh fuel may be burned. This can be accomplished by the alternate or coking method of firing in which fresh fuel is applied to only a portion of the fuel bed while the remainder presents a glowing hot surface, or more effectively, by the use of so-called "two-zone" or "fire arch" heaters or boilers designed especially for the use of bituminous coal.

OPERATION OF HOUSE HEATER

(1) Heating surfaces should be kept clean and free from soot and ash accumulations, and the entire ash pit should be cleaned daily.

(2) Grates should be true and not warped, should move easily, and should have no broken places for coal to drop through. Unburned or partly burned coal should not appear in the ashes at any time.

(3) The fuel pot should be kept full with fire surface at the level of fire door; let ashes accumulate on (not under) the grate in mild weather. Grates should not be shaken too long nor violently, and clinkers should be removed with as little disturbance of the fire as possible. *Do not shake or disturb a very low fire until you have added and ignited a little fresh fuel.*

(4) Anticipate the heating demand by firing promptly when the outside temperature *begins* to drop, or the wind increases. Do not allow a fire to burn too thin nor to develop holes in the fire bed.

(5) If the heater is small for its work, do not use coal containing a large amount of fine material.

(6) The house should be kept at a uniform temperature and should not be allowed to cool down more than ten degrees at night.

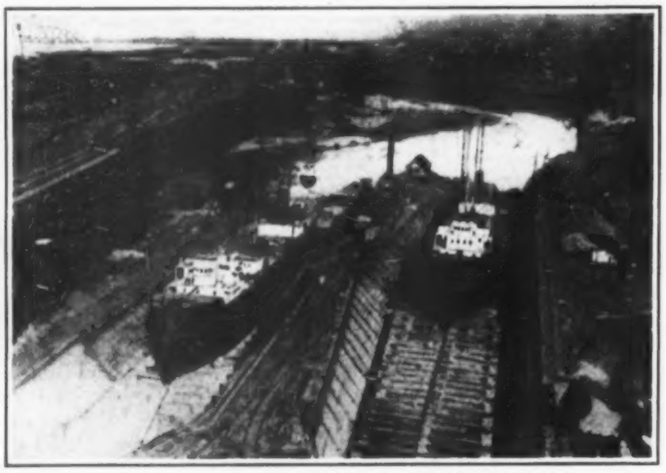
(7) The temperature of all rooms should be as low as is consistent with comfort. To heat a house to 75° F. instead of to 70° F. with an average outside temperature of 40 °F. for the entire heating season means a 17 per cent increase in fuel consumption.—The foregoing is a brief summary of facts developed in Circular 4 of the Engineering Experiment Station University of Illinois.

Poultry Culture—Home Production

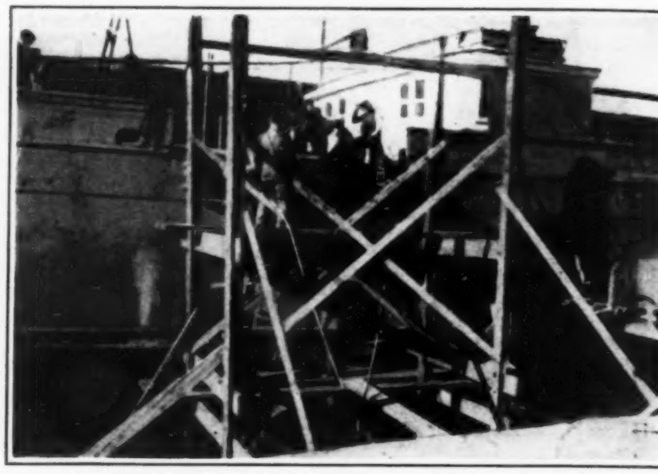
It is necessary to remind readers to use all possible efforts to make every fowl kept in the town or country poultry yard or run a certain source of profit during the winter season. A cardinal feature is the hen's productiveness from October to March, on which so much depends; 100 eggs per bird should be the utility poultry breeder's desideratum to ensure present and future success. One often sees old and useless birds, with immature chickens (whose development may be expected next spring), and surplus cockerels running about. This is a great mistake and unpatriotic, reducing the profits of any poultry yard. Such birds are best utilized for the table. One male bird is sufficient, providing the best is selected; in fact, unless the poultry-keeper intends to breed from his stock there is no necessity to keep one at all. Experiments prove that where hens were kept without a male bird, eggs were produced at about 30 per cent less cost than exactly similar pens in which cocks and cockerels were kept. In some cases the percentage of eggs was nearly a third larger in pens where no males were kept. The crowing is often a source of annoyance to neighbors. At the approach of winter it is necessary to warn poultry-keepers to avoid nondescript or mongrel fowls, for it is an accepted fact that pure pedigree utility breeds—even pure cross-breeds—are more profitable as egg or flesh producers than the class of fowl whose strain and pedigree are unknown, which cost equal attention and food, with uncertain results; while those who have an eye for beauty and elegance will always appreciate a well-bred fowl. Choose the breed or variety of poultry preferred from the many profitable kinds found in this country, and by selective breeding do the best each season to improve its general appearance, quality, and usefulness, especially the laying powers, by most careful or scientific selection of birds (male and female) used in the breeding pen, thus improving the utility side and keeping type in view.

It will be found that the man who specializes with one particular breed or variety is generally successful, "One man, one breed," being an excellent motto which the writer (after a life experiment) has never known to fail. Success may not always be obtained the first season, but persistence and cultivation of the true fancier instinct will be surely rewarded in the near future. During the winter months it is a patriotic duty for all who possibly can to become producers, and thus assist the nation's food supplies. Fortunately, poultry culture can be commenced at a moderate cost, and in confined space; while to all above military age, wives and families of those fighting the enemy, and women young and old, poultry keeping offers exceptional advantages. There are but few households where a flock of hens could not be kept successfully (free from rent or labor), and fed entirely on food unsuitable for human consumption. Suburban gardens, small holdings, and pasture land should without further delay be converted into poultry yards, which, after a little experience, would be associated with pleasure and profit. It will encourage intending home producers to learn that small flocks of poultry in limited areas give the best results, while eggs are produced at a less cost than on extensive poultry farms. For a few pounds every householder can become a producer. The best designed and most hygienic of poultry-houses can be obtained for a few pounds, while half a dozen well-bred utility pullets or hens over moult will, (with the rapidly increasing price of new-laid eggs) soon pay for their initial outlay.

In all progressive poultry-yards (small or large) the breeding pens for next season have ere this been considered, and stock birds selected. This is most important. Late-moulted yearling hens of reliable winter-laying strain demand first attention, and should be kept in as vigorous condition as possible. Mated to a high, fecund, early-hatched cockerel, good results are assured. Such methods refer to egg and flesh producing stock, and it is not too early to make definite arrangements for spring hatching. A choice can be made from winter-laying strains of White Wyandottes, Rhode Island Reds, Light or Speckled Sussex, Croad Langshans, White or Buff Orpingtons, Salmon Faverolles, Plymouth Rocks, barred or buff, all of which (heavy) breeds will (if strain is considered) prove most reliable winter layers and should be hatched in March and April. The smaller breeds, such as white or black Leghorns, Anconas, Campines, La Bresse, Minorcas, Houdans, or Sicilian Buttercups, hatched in April and May, give best results, and actually benefit by close confinement. January to June is acknowledged to be the best term for rapid flesh production, while Great Britain can boast of possessing the best breeds for the purpose, viz., the Dorking, Sussex, Faverolle, or Buff Orpington, and first crosses of these will be satisfactory. Purchases of uncubators, rearers, coops, poultry foods, and grain will be found a good investment before the year closes. For egg production on a small scale with methodical feeding the maximum cost per bird need not exceed 4½d per week, while the attention required is hardly an hour daily. All foods must be kept in dry storehouses.—*London Daily Telegraph.*



At a yard of the American Shipbuilding Company at Cleveland. Lake steamers in dock ready to be cut in two for transit



An essential preliminary in the process. Workmen fitting the "master shell-plate" on board before the hull is cut in two

Bringing Ships from the Great Lakes to the Atlantic*

Vessels Cut in Two to Enable Them to Pass Canal Locks

In addition to the very large amount of tonnage in the harbors of the United States allotted for freight purposes in the service of the Allies, and also the large numbers of new and special type ocean-going cargo-carrying craft building and projected, the United States and Canada are bringing into service additional craft ordinarily devoted to the freight service on the Great Lakes. The giant grain and prairie produce transport-vessels employed on the lakes are, as our illustrations show, being specially altered, in order to reach ports where they can start across the Atlantic. Many of them are again as the illustrations show—craft of considerable size; in consequence of which they have, at the outset, to be cut in two, so as to enable them, half a ship at a time, to navigate the Welland Canal, the short canal which acts as conduit-pipe between Lakes Erie and Ontario. It links the entire system of the Great Lakes with the St. Lawrence and Montreal. At Montreal, there is direct access to the sea for ocean-going vessels; and there the half-sections of the Great Lakes steamers are joined together again and made ready for service, and sent to various places to ship cargoes.

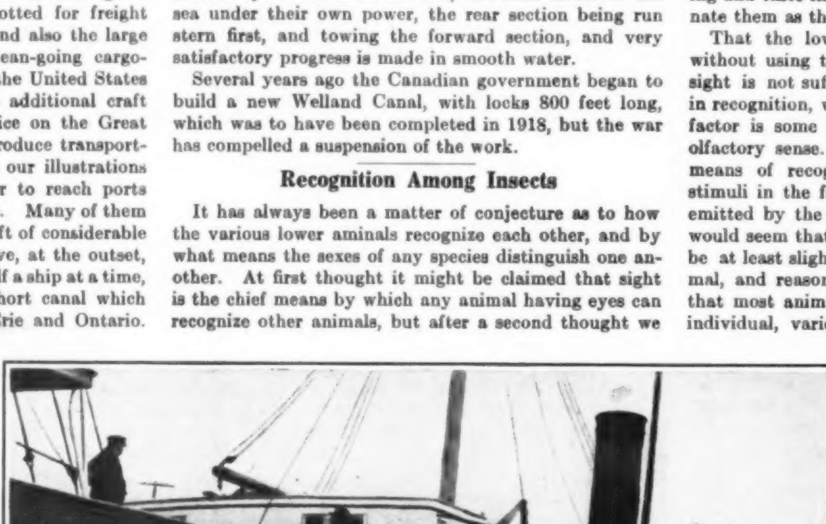
The cutting in two of the Great Lakes vessels is necessitated, as said, by the existence of the Welland Canal. The Canal was constructed in order to connect Lake Erie at Port Colbourne with Lake Ontario at Port Dalhousie. Although the Canal is less than twenty-seven miles in length, it has 26 locks, which are only 270 feet long, which are required owing to the difference of water-level between the surfaces of the two lakes. The Falls of Niagara are situated between Lakes Erie and Ontario, and the Welland Canal runs between them, parallel to the Niagara River. It was built to get over the otherwise insurmountable difficulty of the Falls. The locked channel of the Welland Canal acts like the constricted central portion of a sand-glass joining the bulbs, as an obstacle only to be circumvented by cutting the ships in two.

The work of shortening the hull-lengths of the vessels of the Great Lakes freight service is carried on at the yards of the American Shipbuilding Company, which are situated at Cleveland in Ohio. The "freighters," as the vessels are locally called, are cut in two there: otherwise they could not pass through the short locks of the Welland Canal on their way to their ultimate destinations. The procedure is as follows: The ships are placed in dry docks and cut in two sections with acetylene-gas torches. The sections are boarded in and caulked; after which the dock is flooded and the sections are hauled apart. They are then towed through the Welland Canal, and, further on, through the locks of the St. Lawrence River to Montreal, where the halves are rejoined and made seaworthy.

Many of the lake vessels, which have their entire machinery in the after section, are sent down to the sea under their own power, the rear section being run stern first, and towing the forward section, and very satisfactory progress is made in smooth water.

Several years ago the Canadian government began to build a new Welland Canal, with locks 800 feet long, which was to have been completed in 1918, but the war has compelled a suspension of the work.

*The London Illustrated News.



After the cutting in two has been completed. The two sections of a freighter, the "North Wind", being gradually hauled apart in dock

Recognition Among Insects

It has always been a matter of conjecture as to how the various lower aminals recognize each other, and by what means the sexes of any species distinguish one another. At first thought it might be claimed that sight is the chief means by which any animal having eyes can recognize other animals, but after a second thought we recall that the eyes in the lower animals are not as highly developed as they are in the higher animals; and we know that many of the lower animals live in dark places and that some of them are partially or totally blind. For example, the eyes of some beetles and spiders inhabiting caves function little or not at all, and despite this fact, these animals seem to distinguish one another as easily as do those with normal eyes living in light places. Relative to blind or partially blind species, touch may be the chief means by which they recognize one another, but during the courtship of cave spiders the writer (1910) observed that the males recognize the females of the same species at short distances and even before the males touch the webs of the females. Touch, therefore, can not be the chief means of recognition for cave spiders and perhaps not for any other animal. Since we know so little about the senses of hearing and taste in the lower animals, we may safely eliminate them as the chief factors in recognition.

That the lower animals do recognize one another without using the tactile organs, and as their sense of sight is not sufficiently developed to be the chief factor in recognition, we may assume that the most important factor is some chemical sense, perhaps similar to our olfactory sense. If the olfactory organs are the chief means of recognition, they must constantly receive stimuli in the form of odors, and these odors must be emitted by the animals themselves. If this is true, it would seem that the odor emitted by one animal should be at least slightly different from that of any other animal, and reasoning in this way Jaeger (1876) believes that most animals emit odors peculiar not only to the individual, variety, race, and species, but also to the genus, family, order, and class, and that these odors are the chief means by which one animal recognizes other animals. Without the aid of the eyes he claims that the degenerate human olfactories are able to distinguish a horse from a cow, a goat from a roe, a dog from a cat, a martin from a fox, a crow from a pigeon, a parrot from a hen, a lizard from a snake, and even a carrion crow from a hooded crow. Blackman (1911) remarks that the anal mucous membrane of our domestic animals, particularly the dog and cat, contains glands whose secretion emits a comparatively mild odor which probably serves as a secondary sexual purpose, but in other carnivores, such as the otter, badger, wolverine, mink, martin, ferret, ermine, weasel, and skunk, the scent may be far from mild and in many cases is used either as a means of defense or offense.—An abstract from Smithsonian Miscellaneous Collections, vol. 68, No. 2. N. E. McIndoo, Ph. D.

Hardness of Metals

At the autumn meeting of the Institute of Metals, London, Prof. T. Turner criticised Le Chatelier's suggestion that it was impossible to measure hardness, since the quality in question followed neither the law of equivalence nor that of accumulation. This was to unduly restrict the use of the word "measure." He defined hardness as the property whereby one body was able to penetrate another; and said that this was really equivalent to Osmond's definition of hardness as "resistance to permanent deformation," and to Hadfield's definition as "resistance to deformation." He did not consider resistance to wear and hardness as interchangeable. All hardening was due either to alloying or to cold working. Hardness produced by cold working was, he suggested, due to the amorphous films being in a state of tension. The interior of the crystals was thus in a state of compression. On this view it was easy to see why it was impossible to harden the whole of the material of a bar by cold working it.

Immediately after the cutting-in-two process is finished. The "North Wind" with the hull parted amidships—showing the vertical cut

Ready to begin the voyage through the Welland Canal. The stern section of the "North Wind," afloat, boarded up and watertight

Chalk Flints and the Age of the Earth

STANDING by the new lighthouse at Beachy Head, in front of the grand cliff section there exposed, even the casual and ungeological observer must be struck by the curious black lines in the chalk. These are the well-known flints of the Upper Chalk. We notice how they occur here in more or less parallel lines, following the stratification of the chalk. Also that they are some three or four feet apart. They present a geological problem of considerable difficulty. So far as the writer is aware no theory which goes into precise details as to the actual method of the formation of these *lines of flints* has yet been brought forward. Those who have written on the subject have confined themselves to generalities. They have suggested the growth in the Cretaceous ocean of crops of sponges, and other silicious organisms. To account for their repetition at approximately regular intervals, no better suggestion has been made than that of Prof. Owen long ago. According to this view they are the remains of *successive* crops of sponges which grew again and again according to *some periodic law*. Assuming this—and it seems quite the most probable explanation yet offered—we have to ask, What was the length of the period, and what was the cause of the periodicity? First as to the length of the period between the successive crops of sponges. Prof. Sollas, in his estimation of the age of the earth, takes one foot in 100 years as the average rate of rock formation. But chalk is generally held to be a rock of much slower formation than many others. One geologist, indeed, suggests one foot in 1,000 years as the rate at which it was accumulated. Let us, then, take 6 inches of chalk in a century as a rough compromise. Since the remains of the successive crops, our lines of flints, are some three or four feet apart we have an interval of from six hundred to eight hundred years between each growth. A crop of sponges, then, flourishes for a certain time, dies, and is covered up with chalk. An interval of 600 years, or more, elapses, and a similar crop appears over the same area of the ocean. There may be even the *same species* of sponge in the new layer. But whether they are the same, or new species, the difficulty is about the same. For 600 years there have been no sponges in this particular area of the chalk ocean. Where have the reproductive spores for the new crop come from? Not from the previous one. They could not have been floating about in the ocean all those centuries. The only possible suggestion is that they migrated away from the region, propagated themselves elsewhere for 600 years, and then floated back in the form of reproductive spores to their former home. These settling down produced the new crop of sponges, the succeeding line of flints. To be driven to such a suggestion is almost to confess a *reductio ad absurdum*. There seems to be absolutely no reason why the sponges should *leave* the area, and equally none for their *coming back*. And species of sponge coming back in that way would naturally do so gradually. They would not thus form a layer of flint keeping more or less to the same level in the chalk. At the periphery, where they entered the area, they would be *lower* in the chalk, and gradually rise. The flint layer would also be thicker in one direction, and thin out gradually.

And what about the cause of the periodicity? Nature knows no periods of 600 years' duration. She celebrates no jubilee, as it were, nor does anything different from what she has been doing, at the end of such a time. To assume such periods is not geology, which is tied down to explain the past by the present. The *only periods* observed by nature effecting rock formation would appear to be *annual*. And such periods it must be supposed *would* leave their mark in the making of rocks. Thus the deposits of summer may differ from those of winter, or there may be seasonal pauses in sedimentation, which will leave their mark. It may be suggested that these marks of periodicity may often be read in the rocks themselves. If, then, the lines of flint in the chalk *are* periodical growths, must not the periods be *years?* Must not each line of flint with its covering of three or four feet of chalk be the product of one year? A growth of sponges might take place during the summer months. As winter approached numerous free-swimming reproductive spores might be liberated, and the old sponges dying might be covered up. In the spring the reproductive bodies might settle down to produce a new crop. There is, at any rate, nothing impossible in such a course of events. But if so, we get a rate of rock formation of three hundred or four hundred feet in 100 years instead of one foot. Prof. Sollas's modest 26,000,000 years for earth history is reduced to 86,666 or 65,000. To most geologists, perhaps, this will appear as great a *reductio ad absurdum* as the one indicated above. Yet it seems, on the *assumption* of periodic growths, the only possible solution. And after all, there is no certainty either in Prof. Sollas's 26,000,000, or in the 100,000,000 arrived at by other lines of investigation. These figures—and, indeed, much larger—*are required* by evolutionists, but they have not been *proved* by geology.

And the case of the chalk flints does not stand alone in suggesting a quicker rate of rock formation than one foot in 100 years. Without here bringing forward details, it may be stated that every rock specially studied by the writer from this point of view seems to indicate a rate of formation *much greater* than one foot in 100 years. But the chief point it is wished to emphasize is, that every rock may be made to tell us something—quite roughly, of course, in many cases—of the time it took in the making, if carefully studied. And further, that in not a few cases the actual thickness formed in a year is made clear in the structure of the rock itself.

A reconsideration of the one foot per century measure is required.

Since writing the above my attention has been kindly called by Prof. Grenville A. J. Cole to a suggestion of his own on the subject of the origin of flint. "The rhythmic deposition of flint," he says, "may be due to some action in a limestone mass in which the silica was at first uniformly diffused."

Prof. Cole also refers to the work of Liesegang on Geological Diffusion, on which his opinion was founded. And he further points out that Liesegang himself suggested an application of his experimental results to the explanation of chalk flints. "Liesegang," says Prof. Cole, "compares the layers of flint with the zones of regular deposition that occur in cases of diffusion of one substance through another, and suggests that the silica in the chalk was formerly diffused fairly evenly, and that a progressive one-sided precipitation then took place."

The suggestion is an interesting one, and has a very important bearing on the question of the origin of chalk flints. I have not seen Liesegang's paper, nor do I know the details of Prof. Cole's suggestion, and so am not aware whether they consider this segregation of diffused silica to be sufficient in itself, *without the periodic growth of sponges*, to account for the facts. This is the important point as regards my original note. If it is put forward as the *complete* explanation of the occurrence of the flints in more or less regular layers I am afraid I cannot accept it. If it is to be considered as a *supplementary* agency I think it is *absolutely necessary*. So far as my chemical and physical knowledge carries me, it appears to me necessary to have some definite starting-points for the segregation of the diffused silica. A growth of silicious sponges would supply this. The silica of the sponge mass might start the process, and thus determine the "local habitation" of the flints. But it would require a considerable amount of diffused silica deposited on the sponges to produce a line of flints. Here, then, the suggestion of Liesegang and Prof. Cole would play its part.

And there appears to be evidence that *animal matter* may start the segregation. For in the chalk there are frequently found the tests of sea-urchins and bivalve shells converted into solid masses of flint.—*Science Progress.*

Structure of Metallic Coatings Prepared by the Spraying Method

COATINGS prepared by Schoop's method of melting the end of a rod of metal and converting the molten drops immediately into spray by the action of a blast of air have been examined microscopically. Such coatings may be obtained in an adherent form even on paper or celluloid. The molten drops are elongated during their flight through the air, so that each has a long tail. The coatings have a fine waved or laminated structure, which is characteristic, and enables them to be distinguished from coatings obtained electrolytically or by other methods. The laminæ are due to the flattening out of the drops on reaching the surface. The union of the particles is a mechanical one, the fibers being felted together, and the evidence does not point to the formation of a true weld. Thus, successive spraying with zinc and copper leaves the two metals separate, and brass is not formed.—Note in the *Journal of the Society of Chemical Industry* on an article by H. ARNOLD in *Z. anorg. Chem.*

Encouraging the Salmon in Alaska

THE U. S. Fisheries Bureau is now making a special effort to improve certain streams in southeastern Alaska so that they may become accessible to salmon. There are in various streams falls impassable at present to salmon which may be opened up so that valuable potential spawning beds will be utilized. Several streams have already been improved, but work has been handicapped by lack of funds and only limited progress has been made.

As reported by Inspector Walker, of the Alaska fisheries service, the obstructions may be grouped into four general classes: (1) Falls caused by rock ledges or strata that have not been worn away; (2) log jams resulting either from natural causes or from artificial obstructions; (3) rock jams consisting of loose rocks or bowlders in such position as to be barriers in themselves or to cause the currents to be so broken that fish can not pass through them; and (4) dams constructed for power purposes, and occasionally dams built by beavers. These barriers either absolutely prevent the ascent of fish, or in some cases are partial obstructions, which the fish may, by extraordinary effort, pass at favorable stages of the water. Many of the log jams change from time to time, usually increasing in size and impenetrability. They are of two classes, (*a*) those where the water flows over the top of the jam and (*b*) where it trickles through spaces between the logs. Often such obstructions, while not of particularly great extent, effectually prevent salmon from reaching spawning ground sthat may be of considerable area.

Funds now being available, the Bureau of Fisheries is taking steps to open up a number of blocked streams. While some good work may be accomplished during fall and winter, it will be necessary to await the favorable weather of next spring before the best results can be accomplished.—*U. S. Fisheries Service Bulletin.*

The Virgin Islands of Great Britain

History, Character and Archeology of a Little-Known Group

By Theodoor de Booy

Since the acquisition of the former Danish West Indies by the United States, and the renaming of the purchased islands "The Virgin Islands of the United States," attention has been drawn to the hitherto little-known Virgin Island group, and incidentally to the islands in the group that belong to Great Britain. A hunt through the literature pertaining to the archipelago will speedily convince the student that where comparatively few works treat on the new possessions of the United States, even fewer deal solely with the British islands and not only are the latter historically almost unknown but their geography even seems to afford but few details. The writer has therefor made an attempt to collect what information was available from different sources and to blend this into a homogeneous whole and while the following pages may contain but very little that is new upon the subject under discussion, it may be the means of saving the student, in search of data pertaining to this forgotten region, hours of laborious investigation.

The very earliest history of the British Virgin Islands is shrouded in darkness. Brief mention is found that these islands were first settled in 1648 by Dutch buccaneers[1] who made them the bases for the ships with which they carried on their piratical raids upon merchant shipping. It seems certain that Great Britain laid claim to the islands as early as 1666 and has owned them without interruption ever since. But how the sea-rovers came to lose these possessions to the British and what class of Englishmen first came to the islands, is not definitely known.

From 1666 until 1793, the islands appear to have existed without any definite administrative organization.[2] It was only in 1773 that a court of justice was created with a civil governor. In 1831 a plot was formed by the negroes to murder the male whites, plunder the islands and seize such ships as might be found in the harbors. They had the intention of carrying off the wives of their former masters to Hayti where they wished to join the citizens of this negro republic. Where in 1733 the government of the British Virgin Islands had helped the St. Thomas authorities in suppressing the rebellion on the island of St. John, the Danes now reciprocated by dispatching a man-of-war to Tortola in order to intimidate the rebels. The presence of this ship seems to have been sufficient to subdue the negroes and to put an end to their murderous intentions.[3] In 1838 the slaves of the British West India Islands were freed and the estate-owners of Tortola and the other Virgin Islands were from this date on unable to compete in agriculture with the proprietors of plantations on other islands in the Antilles.

In 1867 a legislative council was given to the colony. Finally an ordinance dated May 1st, 1902, placed the islands under the authority of the governor of the Leeward Islands, they forming a separate presidency.[4] The Commissioner in charge of these islands is generally a physician, as the presidency is too poor to be able to support a resident physician as well as a commissioner. Besides being administrator and physician, he holds the office of chief judge, recorder of deeds, etc.

When St. Thomas and St. John were still under Danish rule, the line of demarcation between the Danish West Indies and the British Virgin Islands ran from the north between Little Tobago and Hans Lollik: from thence to the channel between Thatch Island, Tortola and St. John, around the eastern end of the latter and thence through Flanagan Passage.[5] This line of demarcation of course still holds good today for the line between the islands belonging to the United States and those coming under British rule, as the act ceding the Danish West Indies to the United States includes the waters surrounding the islands.

The total area of the islands is about fifty-eight square miles and they consist of over forty cays and islands. They support a population of a little over five thousand inhabitants[6] which number is constantly decreasing. But very few ships call here and the only communication between these islands and the outside world is by sail-boat and by motorboat from St. Thomas. Here are raised the finest seamen in the West Indies. Due to their long familiarity with the currents in the channels between these islands, with the reefs and hidden dangers that are found here, and with the baffling winds caused by the surrounding hilltops, the sailors are the best boat-handlers to be found.

The climate of Tortola and of the other British Virgin Islands is especially good and is at times quite cold with the temperature frequently ranging as low as sixty-five degrees Fahrenheit.

That the trade of these islands is but of little consequence can be judged from the fact that in 1914 the only export of importance was 35,201 pounds of cotton. The imports in 1915 amounted to a value of $41,132 and the exports to a value of $32,805.[7]

The origin of the name of the island of Tortola, meaning "turtle-dove" is unknown. It seems more than likely that the early Spanish discoverers gave it that name, but how it survived from 1493 when the island was first seen, until 1666, cannot be understood.

Tortola lies in latitude 18 degrees, 25 minutes N. and 64 degrees, 40 minutes W. It is an extremely mountainous island, the highest elevation, Sage Mountain, dominating all the surrounding land with an altitude of 1,780 feet. Practically no level land is found on Tortola which is ten miles long by three and a half miles wide. With an acreage of 13,300 of which in 1815 only one-fifth was under cultivation[8], it is to be doubted if at the present time more than one-twentieth of the land is being tilled. The island is surrounded by a number of cays of which the larger are Jost Van Dyke, Norman Island, Peter Island, Beef Island, Guano Island, Great Camanoe Island and Scrub Island. Jost Van Dyke is the more prominent of these cays, having a peak with an elevation of 1,070 feet and is inhabited by some 350 settlers. These settlers rank as even better boat- and fishermen than do the other inhabitants of the British Virgin Islands. Local reports state that they are so confident of their ability as sailors that they have never taken the trouble to learn to swim. In consequence, whenever a mishap occurs to any boat from these islands, it will always be found that such members of the crew as happen to be natives of Jost Van Dyke, will invariably be the ones to be drowned. The origin of the name Jost Van Dyke points to the early Dutch buccaneers who settled here and who gave the name of one of their famous leaders to this island.

Tortola has the same geological formation as is found on St. John nearby, being a mass of trappean rocks. The island is very fertile in parts but is not well watered, only one rivulet being found. Limes, oranges, pineapples and other fruit are grown, and charcoal is also made and exported in small sailing boats to St. Thomas. The vendors of these products come to the markets of Charlotte Amalia on this latter island and are often taken advantage of, as the local merchants know that they are obliged to sell their fruits before they spoil and that Charlotte Amalia is the only place where a sale can be made. In consequence, very low prices are offered in comparison with the prices given for the same products raised on St. John and on St. Thomas and the unfortunate Tortola islanders are either bound to accept these, or obliged to throw their produce away. Of late years, cocoanut-groves are also being planted and it is possible that this industry may prove to be a saving factor in the economic life of the island. In 1904 experiments were conducted for the growing of sea-island cotton, but these experiments were for some reason not very successful and the expectations of an island-wide cultivation of cotton-plants did not materialize. The female inhabitants of Tortola are also expert in the making of a species of drawnwork which finds a ready sale in St. Thomas.

A number of bays are found, and of these, Road Harbor is the more important. While exposed to the southeast, it is protected from all other sides by an amphitheater of lofty hills. It was here that in the beginning of the nineteenth century as many as three or four hundred sailing-vessels used to await the coming of convoys to protect them from capture by French men-of-war and privateers on their homeward voyage, and in those days Tortola was a place of considerable traffic.[9] A number of old forts still bear evidence of the times when Tortola was an island of importance and when it was found necessary to protect the shipping that sheltered here from the raids of buccaneers and privateersmen.

The island is inhabited by about four thousand people who are scattered throughout the mountains, only four hundred being found in the settlement of Roadtown. This settlement stands on the southwestern shore of the bay and is surmounted by the ruins of Fort Charlotte which lie on a spur, 940 feet high, of the main mountain

[1] Aspinall, Algernon E. "Pocket Guide to the West Indies." London, 1914. Page 354.

[2] Dupontes, P. Chemin. "Les Petites Antilles." Paris, N. D.

[3] Knox, Rev. John P. "Historical Account of St. Thomas, W. I." New York, 1852. Page 95.

[4] Aspinall, op. cit. Page 354.

[5] West India Pilot, Vol. II, No. 129, United States Hydrographic Office. Washington, D. C., 1914. Page 51.

[6] Aspinall, op. cit. Page 351.

[7] Harris, Garrard. "The West Indies as an Export Field," Department of Commerce of the U. S. Special Agents Series, No. 141, Washington, D. C., 1917. Page 294.

[8] Anonymous. "West Indian Sketch Book." London, 1834. Page 237.

[9] West Indian Sketch Book. Page 235.

range. Roadtown is a dilapidated-looking village and were it not for the Commissioner's Residence and the custom-house, it would resemble nothing more than a congregation of fishermen's huts with here and there the ruins of larger houses to still prove the former importance of this town. At one time Roadtown was the scene of many condemnation proceedings when captured privateers and free-booting craft were frequently brought to Tortola by British cruisers and these sales in no inconsiderable measure contributed to its resources and prosperity. Roadtown was also for some time made a free port when the British Government proclaimed it as such to attempt to offset the importance of prosperous Charlotte Amalia on the neighboring island of St. Thomas. The only regular communication between Roadtown and the Virgin Islands of the United States is held by a small mailsloop which goes to Charlotte Amalia once a week to get the mail.

Directly across Road Harbor Bay, on the eastern side, lies the small and scattered settlement named Kingston. Some short distance from Roadtown are found the Botanic Gardens and the Agricultural Experimental Station where attempts are being made to exploit the agricultural possibilities of the British Virgin Islands. At the western end of the bay can be seen the ruins of Fort Burt which are also of interest to visitors on the island. A number of other ruined fortifications are found along the coastline. No visitor should fail to explore the numerous bridlepaths leading over the island and good ponies are always obtainable in Roadtown. Ruined sugar estates are found everywhere, for Tortola, like the Virgin Islands to the westward, was also at one time extensively cultivated with sugar-cane. Besides these excursions, the hunting on Tortola is very good and a yachting-trip around its shores would be a source of unending delight. A voyage to Norman Island will remind one of the days when buccaneers had their hold on the Spanish Main. On this cay are found some interesting caverns called the "Pirates' Caves," in one of which some few years ago a chest of treasure was found.

The Island of Virgin Gorda, or the "Fat Virgin" as it was somewhat inelegantly called by the early Spanish discoverers, has never been able to lay claim to the slightest importance. The main part of the island is a rectangle, two and a half miles long by one and three-quarter miles wide, and lies in latitude 18 degrees, 30 minutes N. and longitude 64 degrees, 25 minutes W. From the main body of the island one peninsula runs out from the northeast coast in a direction almost due west. This peninsula is a half mile wide and six miles long. Another peninsula runs due south from the southwest coast and is three and one-half miles long and a half mile wide. The main body of the island has one high mountain, the Virgin Peak, in its center, with an elevation of 1,370 feet. The eastern peninsula ends in Pajaros Point, a remarkable pinnacle rock. The eastern coast of the southern peninsula has been broken up by some violent action of nature into immense granite blocks which are scattered along the shores. Between some of these boulders large pools are found which have the appearance of baths and are erroneously attributed to Indian handiwork. They are, however, nothing but natural formations. A continuance of this peninsula is a small island, Fallen Jerusalem, which, due to the presence of these same granite boulders, presents the curious appearance of a ruined city, this delusion being especially deceptive from a distance. Many of these blocks are from sixty to seventy feet square. They appear to have been hewn out by giants and rest the one upon the other in the haphazard order so often found in freaks of nature of this kind.

The island is very close to Tortola, Drake Channel being but four and a half miles wide between Virgin Gorda and Beef Island, the latter lying off Tortola. Virgin Gorda is badly watered and only two wells are found on the entire island, with absolutely no rivulets. A copper mine, which was formerly worked, is still pointed out to visitors and the presence of silver and gold is said to occur on the island.[10] The total number of inhabitants of Virgin Gorda amounts to but 417 souls. The majority of these live in a small settlement called Spanishtown and make a precarious living by the raising of vegetables and stock, and the producing of charcoal for the St. Thomas markets. Owing to its unproductiveness, Virgin Gorda was never densely populated. It was at one time fortified on account of its strategic position which controlled the channels leading to the other Virgin Islands.

The island of Anegada is the loneliest outpost of the Caribbean Sea and lies 14 miles due north of Virgin Gorda. It is situated in latitude 18 degrees, 45 minutes N. and longitude 64 degrees, 20 minutes W. with a length of nine miles and a breadth of from one to two miles. Its total area is 13 square miles. The island in most places has an elevation of only 30 feet and its highest point is but 60 feet above sea-level. It has always been known as a danger spot for ships proceeding to the Caribbean and to give some idea of the number of wrecks that used to occur here, it may be stated that in the days when St. Thomas was one of the busiest ports of the West Indies, Anegada had more wrecks in two years than the two dreaded localities on the American coast, Cape Race and Sable Island, can now claim in 36 months.[11] Tides and currents are nowhere as swift in the West Indies as they are here and in hardly any other spot of the Seven Seas are such a multitude of reefs and hidden dangers found. Mariners can occasionally hardly see the island owing to the mist caused by spray which forms when the formidable waves of the Atlantic dash against the cliffs. This mist hangs over the island and often hides it completely. It is from this fact that Anegada derives its Spanish name "Drowned Island."

[10]Aspinall, op. cit. Page 351.

Anegada is of tertiary limestone formation built over a core of volcanic origin. It is covered mostly with brushwood and large salt water lagoons are found. These lagoons, as are the lagoons on the Bahamas Islands of Inagua and Andros, are visited at certain times of the year by flocks of flamingoes which come here during the rainy season when their habitats on the Orinoco River in South America are inundated and they in consequence have to go elsewhere for their food. No rivulets exist and although water can be obtained from two curious water-holes named "the Wells" on the northeast coast of the island, the inhabitants generally prefer to drink the rainwater which they catch in their cisterns. The Anegadians make use of the fresh water from "the Wells" for the cultivation of their crops. These curious waterholes are not uncommon in islands formed of coral limestone and are found throughout the Bahamas Islands; they have a mouth from ten to twenty-five feet in diameter and a funnel-shaped formation. They are very deep and the surface rises and falls with the tide, indicating that a subterranean passage communicates with the sea. The water in these wells is not only fresh but is also colder than the sea water.

Anegada was the first settled of all the Virgin Islands and was a favorite resort of buccaneers and filibusterers. These undesirable subjects were driven off by two successive naval expeditions sent out by Henry Morgan when this former buccaneer became governor of Jamaica and waged relentless war upon his erstwhile boon companions. The population was then replaced by settlers who existed upon the large number of shipwrecks that took place here and made so much by these means that they gave but scant time to agriculture or to stock-raising. In earlier days, these wreckers did not hesitate to murder the crews of the unfortunate ships that struck on the island and made no efforts to rescue the drowning. These conditions have now changed owing to the severe penalties that are meted out by the Tortola government, and although the Anegadians still have a tendency to lay pilfering fingers on any unfortunate ship that goes aground here, no actual violence occurs. The island lends itself but poorly to agriculture and has a population of 459 inhabitants[12] who are entirely black or colored. They raise a certain amount of stock and vegetables but spend their time mostly in an anxious lookout for shipwrecks. The greater part of their houses and huts are built from the timbers and other materials of vessels that found a last resting-place on Anegada, and numbers of the wrecks can still be discovered on the reefs surrounding this dangerous island. Copper and silver ore deposits are said to exist but are not being worked. A quantity of buried pirate treasure is also supposed to have been hidden here.[13] Many snakes and a poisonous variety of wasp serve to disturb the otherwise peaceful existence of the inhabitants.

It is an interesting archeological fact that even this island supported a large aboriginal population and numerous deposits, of large extent, consisting mostly of conch-shells, are found upon the eastern end of Anegada and around the shores of the lagoons. These evidences go to prove that the Indians, even if they did not come here for any permanent settlement, at least visited Anegada to obtain a supply of shell-food.

[11]Vaux, Patrick. "A Forgotten West Indian Island." United Empire, Vol. VIII, N. S. Feb., 1917. Pages 99-101.
[12]Aspinall, op. cit. Page 352.
[13]Verrill, A. Hyatt. "A Book of the West Indies," New York, 1917. Page 351.

Salt-cake and Soda-ash in the Glass Industry

In discussing the substitution of other materials, chiefly salt-cake, for soda-ash in glass making, it is pointed out that salt-cake made in lead-lined pans contains only 0.01–0.03 per cent of iron oxide, whereas that made in iron pans contains 0.07–0.13 per cent. Salt-cake made by the Hargreaves process (treating common salt with sulphur dioxide, air, and steam in iron cylinders) is practically free from iron. For glass making salt-cake should not contain more than 0.2 per cent of iron oxide, 1 per cent of free sulphuric acid, 0.5 per cent of undecomposed salt, and 0.5 per cent of calcium sulphate. If the soda-ash in a glass batch be replaced by an equivalent quantity of salt-cake (100 parts for 75 parts of soda-ash), and proper precautions be observed, the quality of the glass should be entirely unaffected. In a batch containing salt-cake a reducing agent -(coal or anthracite) is necessary, and the lime should preferably be added as limestone, as the carbon dioxide then evolved facilitates the escape of the sulphur dioxide produced from the salt-cake.

Common salt is of little value as a substitute for soda-ash. Alkali metasilicates have also been suggested as substitutes for soda-ash. Their value in practice would depend upon the possibility of obtaining them sufficiently pure and at a low enough price.—*Journal of the Society of Chemical Industry.*

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

The Phlogiston Theory

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

The pronunciamento of Lavoisier against the phlogiston theory of combustion must now be considered a fallacy. One of the great and splendid achievements of this century will be to rectify this error of Lavoisier and to give Priestley and his colaborers their rightful positions and honors in the temple of chemical fame.

The article by Prof. Louis Rougier on the Inertia of Energy in the SCIENTIFIC AMERICAN SUPPLEMENT of December 8th inst. verifies the contention of Priestley and proves the error of experiment and fallacy of interpretation made by Lavoisier in his presumed overthrow and destruction of the phlogiston theory. The deductions from this article to support the phlogiston theory of combustion and to reveal the error and fallacy of Lavoisier are as follows:

(1) The phlogiston theory and the inertia theory of energy are identical as to their meaning of the objectivity of firestuff and energy.

(2) Priestley contended that on the combustion of a substance, phlogiston or firestuff emanated from the substance consumed as an objectivity.

(3) Lavoisier oppositely contended that no firestuff emanated from the substance consumed as an objectivity but that the calory or heat of combustion was occasioned from the oxygen combining with the material consumed, because, were phlogiston to emanate from a material on combustion the combined results should *weigh less* than the total material before it was consumed But since by experiment, the combined results of combustion *weigh more* than the total material before combustion, *nothing*, therefore, could have emanated from the material on its combustion, and therefore, the phlogiston theory of combustion is an error of conception.

(4) The error of experiment made by Lavoisier was simply that the *weight* of the oxygen of combination in combustion was so many millions times more than the *weight* of the firestuff discharged by the oxygen that no method of determination of sufficient refinement was in existence to show the difference of weight between them.

(5) Since the error of experiment by Lavoisier was made in terms of gravitation, energy, and matter and since his supposed refutation of the phlogiston theory was made only in terms of gravitation and matter, the scientists of chemical interpretation from that time until today have been deprived of the sense of energy conceived as an objectivity and thereby chemistry has been proportionally belated in its scientific development.

(6) The inertia theory of energy gives to phlogiston the concept of weight or resistance to the stress of gravitation; that the phlogiston of any material system whether in state of physical mixture or of chemical organization, decreases the weight of that system on taking its departure whether by means of radiation or oxidation; that the phlogiston of a material system is an objectivity; and that Lavoisier on account of the lack of refinement in experiment was in error when he proved phlogiston to be without weight and objectivity in the grand scheme of things.

The significance of the inertia theory of energy is of the profoundest importance to the scientific and philosophic progress of our time and which is approached only by that of the heliocentric theory in the days of Copernicus.

The next and greatest of all pronouncements to be made in the scientific and philosophic world will be that *absolute movement is a physical necessity* if the inertia theory of energy shall be sustained.

C. A. BOWSHER.

Varying Position of the Observer of the Heavens

Notes to Assist Him to Realize the Direction He May Be Looking

By Frederic R. Honey, Ph.B., Trinity College

One of the difficulties which meets the observer in his study of the heavens is the natural inability to comprehend his own varying position as the earth—his base of observation—rotates on its axis. He is perplexed by the apparent paradox that at the equator the direction of the zenith is completely reversed every 12 hours, while at each of the poles it is stationary. At the equator the whole of the celestial sphere comes within the range of observation every 24 hours; at each pole one-half—and only one-half—is continually above the horizon. See Fig. 5. The observer whose object is simply to familiarize himself with the relative positions of the stars as they appear to revolve around the earth may be content with the aid of star maps which are invaluable for this purpose. But for the student there are a number of questions which cannot be answered by observation alone. For example, the question naturally occurs: Why is it that the sun, the moon, and the planets appear at varying altitudes above the horizon when crossing the meridian as the earth makes its annual revolution around the sun? The answer to this question paves the way to an intelligent observation, not only of the members of the solar system, but of the fixed stars, when the observers latitude and the earth's position in its orbit are known.

The accompanying illustrations are designed to assist the observer to realize the direction in which he may be looking any hour during the day or night any day in the year. The observations are assumed to be made at the latitude of New York city, and, to avoid confusion in the drawing, all unnecessary circles on the earth's surface are omitted. The sun is selected for observation on account of its great distance from the earth, and because it is in the plane of the ecliptic. Since the orbits of the planets are inclined at small angles to the ecliptic, they are never far from its plane, and as a consequence the illustrations would apply to them when the proper correction is made for the distance above or below the ecliptic, which of course depends upon the position in the orbit.

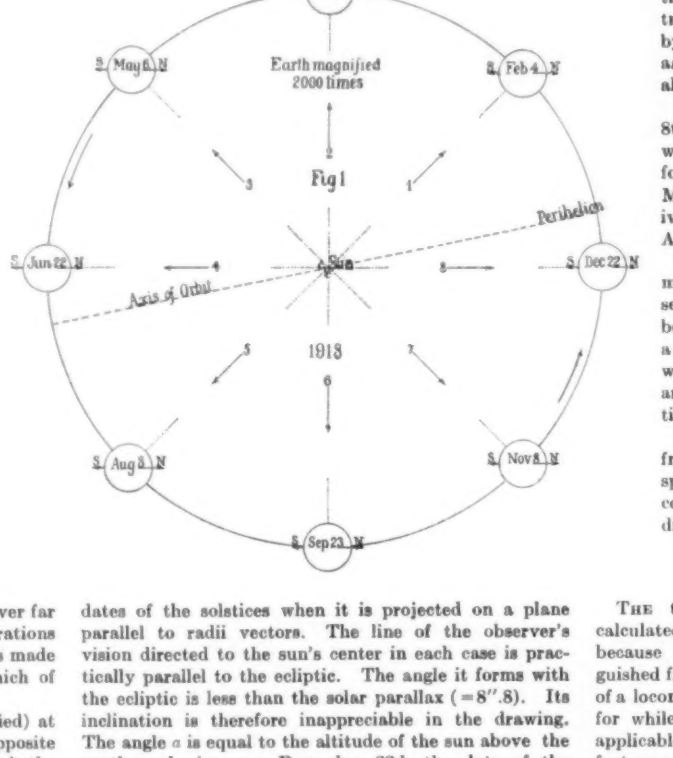
Fig. 1 represents the earth (very highly magnified) at intervals of 45° of longitude, *i.e.*, at four pairs of opposite points in its orbit. The axis is produced beyond the earth's surface, showing the directions of the north and south poles of the heavens. Since the axis moves into parallel positions, its projections on the plane of the ecliptic are also parallel. They coincide with the radii vectors at the dates of the solstices, and are perpendicular to them at those of the equinoxes.

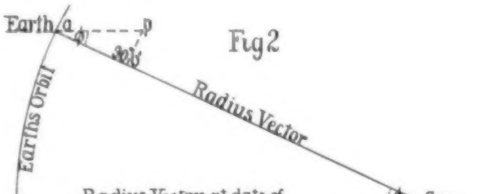
Projections of the earth on planes perpendicular to radii vectors are equivalent to representations as seen in the direction of the arrows radiating from the sun; and the apparent angle of inclination of its axis is determined as follows. Fig. 2 represents the position of the earth in its orbit at any given date, its radius vector, and also at the date of the summer solstice. The polar radius (very highly magnified) is projected on the plane of the ecliptic at o p which is equal to its true length multiplied by cos 66° 33′ ($=\Theta$), the angle of inclination of the axis. Fig. 3. Make o p = o′ p (Fig. 2) and p P = polar radius multiplied by sin Θ. The projection of the polar radius is o P. The value of P for any date may be found as follows. The angle between o p and the radius vector (Fig. 2) is equal to ϕ the angle between the radii vectors, and o′ p = o p sin ϕ. Making the polar radius = unity, P p (Fig. 3) = sin Θ, and o p (= o′ p, Fig. 2) = sin ϕ cos ϕ. Therefore $\tan\rho=\frac{Pp}{op}=\frac{\sin\Theta}{\sin\phi\cos\Theta}=\frac{\tan\Theta}{\sin\phi}$. At the date of the solstice the projection of the axis coincides with the radius vector, and $\phi=o°$. Therefore $\tan\rho=\infty$, and $\rho=90°$. At the date of the equinox $\phi=90°$, and $\frac{\tan\Theta}{\sin\phi}=\tan\Theta=\tan\rho$. *i.e.* $\Theta=\rho$. The axis is parallel to the plane of projection, and the angle is projected in its true value.

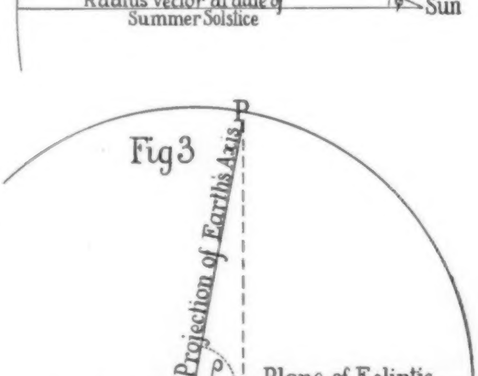
Fig. 4 shows the earth, the equator, and the axis as seen in the direction of the arrows Fig. 1. In each position the projection of the axis includes that of the meridian at local noon. The figures are arranged symmetrically *i.e.*, those in one row are repetitions of those in the other inverted.

Fig. 5 is the projection of the earth on a plane which is parallel to its axis and perpendicular to the plane of the ecliptic. It combines several illustrations. It represents the northern hemisphere as seen in the direction of the arrow 2, Fig. 1, *i. e.*, at the date of the vernal equinox. The axis and the meridian at local noon are represented by the same straight line inclined at 66° 33′ ($=\Theta$) to the ecliptic. Fig. 6 is the projection of the northern hemisphere on the plane of the ecliptic. The equator and the parallel of New York city are projected in straight lines in Fig. 5, and in ellipses in Fig. 6.

Fig. 5 also represents the northern hemisphere at the dates of the solstices when it is projected on a plane parallel to radii vectors. The line of the observer's vision directed to the sun's center in each case is practically parallel to the ecliptic. The angle it forms with the ecliptic is less than the solar parallax ($=8''.8$). Its inclination is therefore inappreciable in the drawing. The angle α is equal to the altitude of the sun above the southern horizon on December 22d, the date of the winter solstice; and the angle ϵ is equal to the altitude on June 22d, the date of the summer solstice.







Projection on plane perpendicular to Radius Vector

The earth rotates in the direction of the arrow a, and the directions of the zenith and of the southern horizon, which are labelled respectively Z and S, are shown by arrows during one-half a rotation. The former radiate from the center of the earth, and the latter from v which is the vertex of a cone tangent to the earth along the latitude circle. This point is v′ in Fig. 6, from which tangents to meridians are drawn representing the directions of southern horizons.

The altitude of the sun at the date of the vernal equinox (March 21st) is found as follows: The line of vision is parallel to the ecliptic and therefore parallel to the trace of the plane of the meridian. This plane is rotated about its trace o c until $C_{\prime}$, the position of the observer is brought into the plane of the ecliptic at C′. The line of vision $C_{\prime} C_{\prime\prime}°$ and C′ C″ before and after rotation, are parallel to o c. C′ c is drawn tangent to the circle and produced to meet the trace at c the same point in which it is intersected by v′ $C_{\prime}$ produced. The angle γ between C′ c and C′ C″ is the required angle of the sun's altitude.

By similar constructions the angles β (Nov. 8th) and δ (Aug. 8th) are found and in the same way the sun's altitude at noon may be determined for any day in the year. The angles for Feb. 4th, March 21st, and May 6th, correspond respectively with those for Nov. 8th, Sept. 23d and Aug. 8th.

It should be noted that if the drawings were made on a large scale the earth would be represented as an oblate spheroid; and there would be small corrections for refraction. Also there are a number of checks for accuracy in drafting which will readily occur to the student, and which are omitted here to avoid confusing the illustrations.

Referring again to Fig. 1, the arrows radiating from the sun and which are numbered to correspond with the projections in Fig. 4, should be compared with the views of the earth as indicated by the arrows in Fig. 6.

Tractive Effort and Horse-Power of Locomotives

The tractive power of a locomotive is easily calculated and reliable. The horse-power is elusive because variable. Occasionally a layman, as distinguished from a railroad man, asks about the horse-power of a locomotive, and the railroad man is at a standstill, for while that particular unit of measurement is easily applicable to stationary engines, it is not entirely satisfactory when applied to locomotives which instead of exerting any fixed rate of power continuously work under conditions varying almost every minute, from those exerting the full maximum power or pull to those requiring little or no effort, as when the engine is drifting or doing light work.

If the work of the locomotive were continuous, on a perfectly level track at a fixed speed with a certain load, the rated horse-power would be of some value. The rated tractive power is simpler, as it indicates correctly the pull at the start. Experiments have shown that it takes about sixteen pounds of tractive effort to start one ton on a level track, and as the speed increases the tractive force necessarily diminishes to as low as six pounds per ton. When fully loaded, steam is admitted to the cylinder nearly the full stroke of the piston, and the consequent large use of steam is very great, and it is exhausted at a high pressure. As the speed and momentum increases the supply of steam is cut off at less than one-third of the stroke, and the amount of steam used is reduced to a minimum, so that while the speed is increased the power exerted is diminished. This is in accordance with a well-known law of physics. At curves or grades, a greater power is brought into action. In the early days of the locomotive, when steam pressures were low and slide valve gear was constant, the indicated horse-power had a more stable value, because the power exerted was almost constant.

Under certain conditions and at certain speeds it may still be calculated. Several years ago an Atlantic type passenger locomotive, while running 70 miles per hour, developed 2,000 horse-power, which at that time was the greatest power developed, the heavy freight engines of that time having fallen far short of that performance because of their slow movement. However, with the introduction of superheating appliances and the consequent development of the present day locomotive, it is not now uncommon to find locomotives developing several times that amount. But in the majority of cases the amount of tonnage which ought to be assigned to a locomotive is more easily grasped when referred to the starting effort and capacity at six or eight miles an hour rather than upon its power at higher speeds.

In calculating the drawbar pull or tractive effort of a locomotive at starting speeds the following is the formula in general use: Multiply 85 per cent of the boiler pressure in pounds per square inch by the square of the diameter of the cylinders in inches, and multiply this amount by the length of the stroke in inches, dividing the product by the diameter of the driving wheels in inches. For example, supposing the boiler pressure is 200 pounds per square inch, diameter of cylinder 27 inches, length of stroke 30 inches. Then $170 \times 729 \times 30 \div 63 =$ 59,000 pounds tractive power.

It may be added that while much more could be said on the subject, it has been found that the tractive power of a locomotive is more readily applicable than the horse-power, and an approved ratio between the two calculations is about 18 to 1 so that a tractive effort of 54,000 pounds would be about 3,000 horse-power, at a particular speed. —*Railway and Locomotive Engineering.*

Repair of Concrete Pavements

By A. H. Hinkle
Deputy Highway Commissioner of Ohio State Highway Department

Clean the crack or joint of all dirt, manure or other foreign matter. This cleaning can be done by the use of an iron hook and brooms. Use wire or rattan push brooms, finally removing the fine dirt by sweeping with house brooms or the use of compressed air. A heavy tire pump may be used for this purpose although this refinement in cleaning may not be necessary. When the crack is clean and dry it may be filled by one or both of the following methods:

Method (a). For small cracks and joints

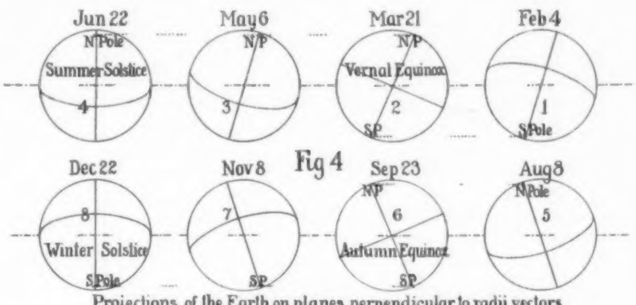
Fill crack or joint full with hot tar, permitting the tar to lap over the spalled edges of the crack, but *not to exceed one inch.* The tar should be hot enough to run readily into the crevices of the pavement (200 degrees to 250 degrees F.).

Great care should be taken that the tar is not injured by overheating. It should never be brought to a temperature where yellow fumes will be given off. Long continued heating at a low temperature will be injurious. For this reason the tar in the bottom of the kettle should be cleaned out occasionally and thrown away. Tar which has been injured by overheating becomes hard and brittle when it cools. Such tar will spall off and chip out of the crack. It will have a very temporary life and be of little service when most needed, i. e., in protecting the edges of the crack or joint.

The tar should be poured from a can with a narrow spout. Immediately after pouring the hot tar, cover it with dry sand or screenings. If sand is used, it should be clean and preferably coarse. If screenings are used, they should consist of No. 6 (one-half to three-sixteenths inch) grit of stone, slag or gravel. If upon cooling, the tar drops below the surface of the pavement, the crack should be refilled, as the secret of this method of maintenance is to keep the crack or joint full. No large excess of tar should be used, however, as it will eventually build up an elevation on the surface which is objectionable to traffic. The covering of screenings or sand should be put on immediately after pouring the tar so that while in the liquid state it will unite with the screenings or sand. This will prevent the tar from sticking to wheels of vehicles or melting during hot periods and running from the cracks. The sand or screenings should be swept back onto the tar, or new sand added, one or more times after it is first applied. This should be done when the tar is soft during hot weather and at such times as the weather and traffic conditions will demand it. During very hot weather this recovering will usually be required within a week or ten days after the tar is poured. During cool weather a much longer period will intervene. If the tar has been poured late in the fall, additional covering may be needed during the oozing atmosphere of the first hot periods the following spring.

Instead of using pure tar as described above, a better method, if properly done, consists in using a mixture of hot tar, T-1, and fine dry sand. Fill the tar pouring can about one-half full with the hot tar. Sift from one-half to an equal amount of dry sand into the tar, stirring same as the sand is added. Pour the tar mastic thus produced into the joints or cracks the same as the pure tar is poured, and cover with sand or screenings. This whole operation should be done rapidly so that the tar mastic will not become cold and stiff before it is poured. If the sand is damp or the weather is quite cool, it will be necessary to first heat the sand.

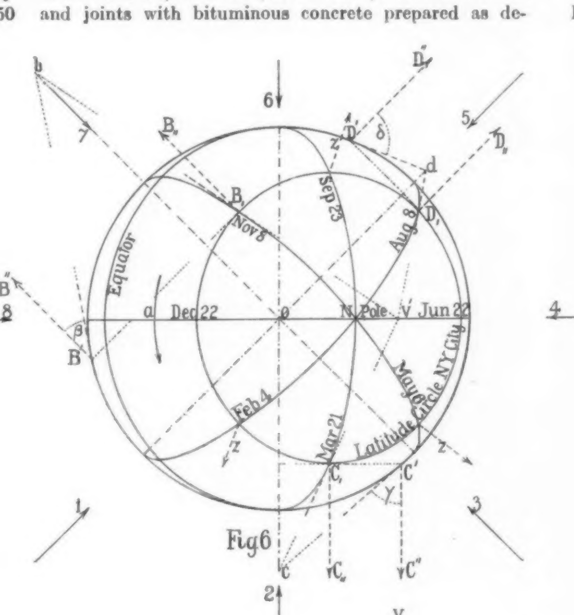
Only a small amount of moisture in the sand will cause the tar to foam. The advantage of using the mixture of tar and sand lies in the fact that it will not melt and run from the crack during hot periods as badly as will the tar when used alone. For this reason it is *especially valuable to use on steep grades.* The amount of sand that can be successfully used in this way will be found by experiments. The amount of sand should never exceed the amount of tar. Any small amount of sand will aid in keeping the tar in place. Use only such portion of sand as will permit the easy pouring of the mastic (tar and sand mixed together).



Projections of the Earth on planes perpendicular to radii vectors Showing equator, axis, and meridian at local noon

Method (b). For large cracks and joints

Paint the edges of the crack or joint with tar to a depth of one inch or more and back sufficiently far on the surface as to completely cover all spalled edges. For this purpose there may be used hot tar, T-1, H. T. 0 1, or the cold tar, T. C. B. (tar cut back). Fill the cracks and joints with bituminous concrete prepared as described below. A sufficient quantity should be used to fill the crack to the level of the surface of the surrounding pavement when thoroughly compacted. After the bituminous concrete is *thoroughly rammed* into the crack, compacted with a *tamping iron* and made to *conform to the adjacent surface* of the pavement, cover it with coarse sand or No. 6 (one-half inch to three-sixteenths inch) grit of stone, slag or gravel, to prevent the bituminous material from sticking to the wheels of vehicles and hoofs of animals. This covering should be about one-fourth inch thick.



Bituminous Concrete for Method (b) above shall consist of an intimate mixture of clean No. 4 (¾" to ¼") stone chips and tar, T. C. B. mixed cold and in the proportions by volume of about eleven parts of stone chips to one of tar. This tar is liquid at ordinary temperature so that it is unnecessary to heat the tar. The stone chips should be clean and dry. The chips are spread thinly (three to four inches deep) on a platform or the smooth pavement, and the tar sprinkled uniformly over them from an ordinary water sprinkling can with the holes in the rose slightly enlarged. The chips and tar are then mixed with a shovel as in mixing cement concrete, turning the mixture a sufficient number of times, depending on the temperature, to coat every piece of stone with the tar. (This will usually require at least six times.) The mixture is then shoveled into a pile where it will be reasonably free from dust and dirt and permitted to stand from four to seven days until the bituminous mixture cures (stiffens sufficiently to properly bind when tamped into the crack). If left exposed to the air the mixture will usually be suitable to use for a period of a week or more after it is cured. If covered with a tarpaulin or other suitable cover, it may be kept in a condition suitable for use a considerable length of time. If it is desired to fill quite small cracks with this mixture a *smaller sized screening should be used.* If a quite large opening or hole is to be filled a larger stone should be used. When the larger stones are used the stone should be graded in size from the larges to the smallest size here mentioned. A small portion of clean coarse sand may be added to the stone to good advantage. The sand, however, must be clean, sharp, and not too fine, or otherwise it better be omitted from the mixture.—*Concrete Highway Magazine.*

Acid-Proof Alloys

It is often asserted that electrolytic corrosion tests of voltaic couples of two metals should be a guide as to the corrosion of the alloys of those metals. The investigation by Dr. Roland Irmann of alloys of copper and nickel, to which tungsten and iron were further added, once more disproves this assumption; much depends upon the proportions and the formation of compounds. Irmann (*Metall and Erz,* pages 21 to 30 and 37 to 42, 1917) was in search of an alloy not to be attacked by strong hot sulphuric acid. He found that an alloy of nickel with 20 per cent of tungsten was much more resistant in this respect than nickel alone; but that alloy was very difficult to machine and expensive, of course. To introduce tungsten into the nickel, he started from copper-nickel. A voltaic couple of Ni and Cu gave an electromotive force of 0.55 volt, which soon went down to 0.25 volt; nickel was dissolved, the copper becoming polarized with hydrogen. Failing to find a more satisfactory binary nickel-couple, he introduced other elements, especially tungsten, into the nickel-copper alloys, studying also the alloys of copper and tungsten. He fused an alloy of Ni-W in an arc furnace and added electrolytic copper; later he used a Helberger furnace, afterwards adding more nickel as required. The alloy consisting of 47 per cent of Cu and 4.98 per cent of W proved highly resistant, and at the same time mechanically very strong, giving also the greatest elongation of these Cu-W alloys; the electric resistance was greater than that of constantan. Very good results were also obtained with ternary Ni-Wi-Cu alloys. The interesting point is, however, that quaternary alloys, further containing iron, proved far superior to the ternary alloys. This is important in so far, of course, as one may, in preparing the alloys, start from ferro-tungsten instead of having to isolate the tungsten first. By varying the percentages of iron—always low—the qualities of the alloys were suitably modified. When the sulphuric acid is to be used in the cold only, one should take alloys relatively rich in copper and also in tungsten and iron. For hot concentrated sulphuric acid Irmann recommends a nickel alloy with 43.65 per cent of Cu, 3.9 per cent W, 1.87 per cent Fe. This alloy also has a very high electric resistance and strength, and can easily be machined; the tensile strength was 28 tons per square inch, and rose to 3,505 tons per square inch in an alloy containing 3.9 per cent of Fe. Some of the alloys, however, rather tended to separate in layers during fusion. Irmann also tried to improve German silver (60 per cent Cu, 20 per cent Ni, 20 per cent Zn) by the introduction of tungsten. But the tungsten would not alloy with the zinc, and he could not get more than 0.4 per cent of tungsten into this ternary alloy.—*Engineering.*

The Biological Aspects of Warfare—II*

Instincts and Restraints That Affect Human Relations

By Harry Campbell, M. D., Lond., F. R. C. P. Lond., Physician to the West-End Hospital for Nervous Diseases, London

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THE TWO SANCTIONS OF CONDUCT

A man's conduct both towards his fellow man and the lower animals has two justifications or sanctions—the self-regarding sanction of might and the "others" regarding sanction of altruism.

Let us first consider the sanction of might—the justification, that is, for exercising might wholly or essentially in the interest of self. It is expressed in the phrase "Might is right." According to this sanction what might can do, that might is justified in doing. The first great truth we have to realize respecting the might sanction is that sheer might, wholly untempered by consideration for others, operates with inexorable effect throughout the whole organic world. In the struggle for existence living things have to contend against one another and against the forces of Nature, and in this struggle those go under that cannot successfully oppose might by might. As regards the struggle between living things, the most lowly may be pitted against and overcome the most exalted, as when man succumbs to a microbic disease, such as phthisis. In a life-and-death struggle of this kind there is no sanction other than might; the victim has meekly to submit to the inevitable. Nor has he from the biological standpoint great cause for complaint, seeing that from that standpoint the lowly tubercle bacillus has just as much right to live as man, the roof and crown of things.

Let us now ask ourselves how far the sanction of sheer might prevails among the higher vertebrates—(*a*) between the sub-human vertebrates, (*b*) between man and the latter, and (*c*) between man and man.

(*a*)—The struggle among the lower animals is signally displayed in the case of the carnivora and their prey. Here we see the operation of might in its grimest and most dramatic aspect. The sole warrant for the butchering activities of these animals is manifestly that of might, although it must be admitted that a measure of altruistic sanction comes into play in the case of the carnivorous mother when she slaughters for the sake of offspring.

(*b*)—We have seen that since the time the pre-human ape took to hunting, he and his human descendants have wrought ruthless havoc among the lower animals. Here, again, the sanction is just that of the other carnivora—the sanction of might—the self-same sanction which permits the tiger to kill the deer or the cat the mouse. Biologically considered, the victims of man and the carnivora generally have just the same right to a place in the sun as their victimizers. Man may perhaps console himself somewhat for his indulgence in this wholesale slaughter by the reflection that if a race of superior beings were to descend upon this planet they would assuredly very speedily enslave or destroy the human race; and still more from the consideration, already urged, that it has been essentially through bloodshed that man has raised himself above the ape.

(*c*)—The might sanction obtains widely as between man and man, both as regards the relations between separate communities, be they savage tribes or great nations, and those between the individual members constituting these communities. The sanction for that subjugation of weaker tribes by stronger which has taken place throughout the entire period of man's tribal career has manifestly been that of might simply. And so, too, as regards the warfare between civilized nations. Even in this year of grace the dread arbitrament of war still continues to be the sole means for settling disputes which cannot otherwise be adjusted. The great nations of the world still refuse to lay aside their arms and submit their disputes to an international tribunal. Men like Treitschke and Bernhardi boldly proclaim that in international disputes might is right, and openly advocate the cultivation of the martial spirit and a prompt resort to arms, if by their means the power and influence of the Fatherland seem likely to be extended. The only gleam of better things comes in the fact that the great powers of the Entente are fighting not only in their own cause but in that of the small, *i. e.*, the weak, nationalities.

Again, among the individual members of a community, tribal or national, we find the strong dominating the weak. This is true even of advanced civilized communities. Actual personal combat is still in some degree sanctioned in the case of the comparatively harmless schoolboy fight and in the more formidable duel. Happily, the latter method of settling personal differences has long since been given up in this country. It is a flagrant instance of the might sanction in its most primitive form: one man injures another; the injured person challenges the injurer, but far from being certain of getting reparation, he as likely as not receives additional injury, if, indeed, he is fortunate enough to escape with his life. Here the sanction is just the same, and just as little justifiable on rational or ethical grounds, as when two great nations engage in war.

The individual is not, of course, permitted unreservedly to exercise the might sanction in his own interests within the State. Without some restrictions (to be considered later) no community could hold together. Nevertheless, these restraints, considerable though they be, leave wide scope for the exercise of personal might in the interest of self, and there are few who fail to take advantage of it. The tendency is for everyone to use such powers as he is free to exercise, without actually breaking the law or acting in violent defiance of public opinion, for the purpose of securing for himself the good things of this world.

The exercise of might within the sanction of the law falls under two categories, though it is not easy to draw a sharp line between them. We may speak of them as the illegitimate and the legitimate.

The illegitimate though legalized exercise of might includes conduct which, though essentially immoral, is yet permissible by law, the fact being that in a complex social system no code of laws can be devised which shall take account of every possible form of immoral dealing. Hence it is possible for a person, without breaking the law, to use his might in a manner which has little or no moral justification. Large fortunes are made in ways which, though not illegal, are yet violently opposed to the spirit of altruism, as in the case of the man who establishes a corner in wheat, the employer who sweats his workers, the usurer who lends money at exorbitant interest. Many of these procedures are sanctioned by general consent, though they are little more than modes of legalized robbery. Has not the informed and skilful speculator something in common with the house-breaker? Each uses his skill in annexing the property of others by taking advantage of their ignorance, while he renders no manner of service to the State. Is it not, again, a matter of daily experience that when a person, no matter what his social position, has the legal power to squeeze another in his own interest he seldom fails to take advantage of it?

We come now to the second category—the legitimate exercise of might in furtherance of self-interest. Some people are endued with greater powers than others, and society sanctions the exercise by the individual, in furtherance of self-interest, of such powers as he possesses, provided he does not infringe the law or act in flagrant defiance of public opinion. Herbert Spencer's formula of Justice runs thus: "Every man is free to do that which he wills, provided he infringes not the equal freedom of any other man."

Now, it will be found on ultimate analysis that the sanction here is not that of ideal justice—at least, not of ideal justice as I conceive it—but just that of might. Ideal justice demands, so it seems to me, that all shall start life equally endowed (both as regards native powers and worldly goods), and further that all shall be afforded equal opportunity. But neither of these conditions obtains nor can obtain. Nothing is more certain than that all are not equally endowed: Dame Fortune distributes her favors in an entirely haphazard fashion. Some are gifted with a larger native endowment than others in the matter of health, beauty, intelligence, force of character, or what not, and are able to reap corresponding advantages. Some, again, are born rich, others poor, and what cannot the power of wealth accomplish? The moneyed fool can command the service of multitudes and enjoy in abundance the good things of this world, while the penniless genius may starve in a garret. Then as regards differences of opportunity. Some are born under conditions affording little scope for native endowment to come by her own. Village Hampdens and mute inglorious Miltons are more common than we think. A man who attains to modest eminence in a small provincial town might, had he sought his fortune in the New World, have made his millions; or a village beauty who, like the heroine of that beautiful poem "Maud Muller," has had to content herself with an uncouth swain for consort, might, had she been afforded the opportunity to display her charms behind the footlights, have blossomed into a peeress. Power without opportunity is powerless.

Under ideally just conditions, which require that each and all shall be equally endowed as to person and opportunity, no one could secure an advantage over his fellows from the possession of an extra share of might. It may be argued that even under such conditions it would still be possible for some by superior industry and grit to outstrip others in the race for life's prizes and thus secure a legitimate reward for having of *their own free will* made the best of their talents. To which I would reply that this very industry and this very grit are part and parcel of the individual endowment. Here we are up against the old question of the freedom of the will. To me it seems that equality of endowment implies equality as regards industry and force of character, and that feelings, thoughts, and acts conform to undeviating laws.

We thus see that ideal justice is not possible, but we are not on that account to suppose that everyone ought to forgo the special benefits which blind fortune may have bestowed upon him, or that an attempt should be made to secure ideal justice by a quixotic altruism. It is idle to strive after the impracticable or to seek to over-ride the great biological law of struggle: throughout all living nature the battle is, and ever will be, to the strong. A vigorous individualism, subject to necessary legal restrictions and tempered by a generous altruism, is the ideal to be aimed at. Subject to these reservations, might is a legitimate sanction. My object has merely been to show that this sanction operates with potent effect, even in the most advanced and best regulated communities.

(Note.—The conclusion here arrived at as to the legitimacy of exercising might within the limits specified has the authority of Herbert Spencer. He points out that except in the case of the immature, throughout the entire animal kingdom the benefits received tend to be in direct proportion to the merits possessed, an arrangement which necessarily secures the survival of the fittest. "Each individual," he insists, "ought to be subject to the effects of its own nature and resulting conduct," a principle which among the lower animals holds good without qualification. Among men there is an instinctive craving for freedom of action, and Spencer maintains that this freedom should be permitted so long as it does not interfere unduly with the freedom of others.)

THE CHECKS TO THE OPERATION OF MIGHT

We have seen how the might sanction operates throughout the entire animal kingdom, and how even in advanced human societies its potency is far greater than appears at first sight. Let us now consider more particularly some of the restraints which limit its operation. Among the most effective of these is the altruistic prompting which leads parents to tend their offspring. This parental instinct is now recognized to be the foundation of all altruism—the generous impulse to work in the interest of others rather than of self.

All animals which tend their young must at least be endowed with just so much altruism as pertains to the parental instinct, whether maternal, paternal, or both. (In the case of mammals the care of the young is for the most part limited to the mother.) It is, moreover, necessary that the entire family group shall be pervaded by something akin to the altruistic spirit, or at least that the members of the group shall not act antagonistically to one another, in order that they may cohere and live in harmony together. In the case of the non-gregarious animals this parental and family altruism constitutes the sole check on the might sanction. Save for its influence the non-gregarious animal (the tiger, for instance) employs all its powers for selfish ends alone.

In the case of gregarious animals other checks come into play, but before dealing with these it will be well to examine into the purpose of gregariousness. Its object is mutual help. By union into an organized community the welfare of each animal in that community may be promoted. Thus the capture of prey may be facilitated, as in the case of the wolf which, by hunting in packs, can secure a more ample supply of food than by individual effort; or again, the union may serve the purpose of protection, as in the case of many of the herbivora (*e. g.*, the deer and the ox), for the herd not only presents a united front to the enemy, but by the multiplicity of its organs of scent and vision is so much the more appreciative of approaching danger. Man's gregariousness has a similar *raison d'etre*. That primitive human families combined into tribes for utilitarian purposes we are very sure. Their union enabled the men to cooperate in the hunt and

*From *The Lancet*.

the women in the gathering and preparation of vegetable food, while it served the further purpose of protection against enemies, human or other. The interest of this utilitarian communal life as bearing on our present inquiry lies in the influence it has had in creating checks on the regime of pure might—checks which, becoming increasingly stringent with the development of communal life, have attained to greatest stringency in the most advanced civilized communities.

And first as to the checks on the operation of might among infra-human communities. My remarks on this head must be brief. It is obvious that no community could hold together if each member worked for its own interest without any reference to its fellows. Some psychic influence, antithetic to the purely egoistic manifestation of might and tending to secure the cohesion of the whole, must be at work. And such is undoubtedly the case. Thus some glimmer of altruism may be observed among the members of the herd in the shape of mutual help, and, again, a harmful assertion of might on the part of one member of the herd may lead to its being chastized by other members or even outlawed from the community, as in the case of the malicious rogue elephant. In short, each member of the herd needs to discipline its conduct in due regard to the others in order that all may live together harmoniously and cooperate for common ends.

And as with infra-human so with human communities—the individual members need to be bound together by psychic influences, which constitute so many restraints on the purely egoistic might sanction. When families began to unite into tribes the altruism, until then confined to the family group, extended to the entire tribe, for some measure of mutual help, however small, was necessary to its cohesion. This also required that certain rules of conduct should be observed, rules which, indeed, in many cases developed a complexity out of all proportion to their usefulness (as in the case of those in force among the Australian aborigines). These rules were not deliberately framed, but grew up spontaneously and were perpetuated and emphasized by tradition. Nor were they enforced by an executive, but simply by public opinion, fear of which ever constitutes an effective check on unconventional conduct. Disputes between members of the tribe—private wrongs such as theft and even murder—were settled privately. The injured persons took the law into their own hands (as we say) and avenged themselves as best they could by retaliation, the fear of which, like the fear of public opinion, always operates as a useful restraint.

It was not, indeed, until a comparatively late phase of social evolution that Government undertook the protection of the individual. In the first instance, its sole concern—its *raison d'etre*, in fact—was the military one of protecting the community against external foes, tribal customs enforced by public opinion, and the fear of retaliation against private wrongs, aided by some measure of altruistic spirit, sufficing to maintain the integrity of the tribe. But something more than these was necessary to protect the tribe against outside enemies. This demanded a central authority in the person of a chief or king, whose business it should be to weld the manhood of the tribe into a fighting force. Needless to say, that at this primitive phase of society there was no question of exemption owing to conscientious motives. The first duty of all the able-bodied men—and these comprised practically the entire manhood of the tribe—was to preserve the integrity of the tribe against attack. We have thus an ancient precedent for universal military service. Assuredly the first duty of a government is now, as it was at the first beginning of communal life, to secure adequate defense of the state against its enemies, and to compel, if need be, all its able-bodied manhood not otherwise required to take up arms against the common foe. The man who is deaf to this elemental call of duty is an undesirable from the eugenic standpoint. From such as him we are little likely to breed a virile race; we must not, we cannot, allow our bravest and best to be killed while the faint-hearted are left to perpetuate the race.

As society developed government undertook the duty of protecting the interests of the individual by enacting and enforcing laws, and thus a further check was put upon the operation of might. Meanwhile another and most powerful restraining influence had come into operation—the fear of divine vengeance. But to trace the growth of the religious element in man would take me beyond the scope of this essay and I merely name it.

The operation of these various checks during countless generations has had a profound influence on man's affective nature. There has evolved in consequence of them a disposition to act in accordance with the requirements of complex social life, for on the whole those most amenable to social discipline and those most altruistically disposed have survived at the expense of the anti-social and the egoistic: there has evolved, in short, a disposition to act morally (*i. e.*, dutifully towards our fellows), and a corresponding sense of justice has been built up. Thus it has come about that from the first institution of communal life among men there has been a steady weakening of the might sanction, so that today civilized man revolts against its unbridled exercise. He realizes that while it is excellent to have a giant's strength it is tyrannous to use it like a giant, and he applauds the "noble doom" which Posthumus imposes upon the man who has wronged him:—

Kneel not to me:
The power I have on you is to spare you;
The malice towards you, to forgive you; live,
And deal with others better.

It will thus be seen that just as communal life has evolved on a utilitarian basis, so also has morality; its function is neither more nor less than the maintenance of the integrity of the social organism. From the biological standpoint it has no other significance. Nor must it be forgotten that sheer might has also its range of usefulness in the animal world, a wider even perhaps than that of altruism. Each is but a means to an end, and biologically neither merits commendation or condemnation more than the other.

THE CHECKS TO THE OPERATION OF MIGHT

It will be observed that the checks on the operation of egoistic might which we have already considered are purely intro-communal, their sole object being the integrity of the community. In the earlier phases of human society they took no part in regulating the relations between separate communities—between family and family or between tribe and tribe. The concern of each unit was its own welfare alone. It did not in the least trouble itself about the welfare of other communities. Consequently the principles which regulated the conduct of the members of any one community among themselves in no way governed their conduct toward other communities. The code of morality within the community did not obtain between individual communities. Rather was there a tendency for separate communities to regard one another with suspicion and animosity, so that incessant inter-tribal warfare may be said to have been the normal condition during the tribal phase of man's history. The more one tribe could injure its neighbours by murder, pillage, and the like, the more did it aggrandise itself, just as the status of the young brave was raised as the number of scalps he could display increased. In short, the sanction of conduct obtaining between separate communities was just that of might, pure and simple. But with the further development of society—with the establishment of nations having commercial relations with one another—agreements of some sort had to be entered into between them, and these international obligations have become more and more binding as civilization has advanced.

Now it might be thought that with the growth of commercialialism, and increasingly intimate social relations between separate states rendered possible by the ever-growing facilities of intercourse and transit, those checks to the operation of the might sanction which obtain within and secure the cohesion of, individual states would in like manner gradually come to unite the nations of the world in one all-embracing commonwealth; and that just as within the properly ordered state conduct is guided and conflicting interests—personal, social, political, religious—reconciled, on lines of justice and commonsense, so also could, and should, international conduct be governed and international disputes be adjusted. But this devoutly-to-be-wished-for consummation is not yet. We have recently seen how a nation may in its dealings with other nations cast aside all moral restraints and revert to the same sanction of might as obtained between the most primitive human communities.

There could be no greater contrast than that between the ethical standard prevailing within a State and that obtaining between States at war with one another. In the one case the motto is, "Let justice be done though the heavens fall"; in the other justice is cast to the winds and the issues are to be decided by might alone. In the one case so high is the value set on life that every opportunity is afforded even to the most atrocious murderer to prove that he is innocent; in the other wholesale slaughter by the most terrible means which the mind of man can devise is sanctioned. In the one case the sanctity of private property and of compacts is rigorously upheld by all the might and majesty of the law; in the other compacts are dishonored and property destroyed or confiscated to the value of untold millions on the sole ground of military necessity. All this is strangely primitive. When the citizens of a well-ordered State have a dispute over conflicting interests, private or social, they appeal to justice, and were anyone to suggest that the issue should be decided by personal combat his sanity would be suspected; but when a dispute arises between two nations and they fail to adjust it by argument it but rarely happens that they mutually agree—especially if the one be more powerful than the other—to submit to arbitration; they appeal instead, they revert to the age-old sanction of might.

THE INFLUENCE OF WARFARE IN MOULDING THE INDIVIDUAL

In considering the effects of warfare on mankind we must distinguish between its educative effects, *i. e.*, its influence in moulding the individual, and its racial effects *i. e.*, its influence in moulding the race. As regards the latter, I have already endeavored to show that, while primitive intertribal warfare operated eugenically by favoring a survival of superior types, modern warfare operates dysgenically by promoting the survival of inferior types. But while modern warfare is thus *racially* harmful, *individually* warfare has always had some educational value, and it would be idle to shut our eyes to the fact. It is remarkable that among primitive communities those which cultivate warfare are generally superior to those leading peaceful lives. It may be argued that they become warlike because they are superior rather than the reverse. Facts, however, tend to show that whether a community is warlike or peaceful depends mainly upon the conditions under which it lives; thus the nomadic career of the hunter and herdsman is favorable to the warlike spirit, while the life of "stationary" (as distinguished from "migratory"), agriculture tends to be peaceful.

There can be no doubt that military training has a beneficial influence, physical and mental, in moulding the individual. Its good effect physically is shown in the rapid improvement in the physique of recruits after enlistment. (At the outbreak of the present war there were far too many contracted chests and round shoulders in this country.) Its value in the moulding of character is no less decided; above all, it teaches discipline and respect for authority, both of which are in danger of neglect in democratic communities. It would be difficult to exaggerate the importance of discipline: it is a prime essential to good citizenship, and it is as needful to the one sex as the other. Every boy and every girl should from an early age come under its rigorous influence and be made to realize not only that it is an essential to right living, but also to individual happiness and success in life; and there is nothing better calculated to inculcate discipline than military training. This, or something equivalent to it, should begin in early school life.

So much for the good that can be got from training for war. What about war itself? While realizing that man has evolved through slaughter, and that every step in his long upward path has been stained with blood, I must confess that modern warfare seems to me as inane as it is horrible. This wholesale slaughter and mutilation of one set of men by another set of men who have no personal quarrel with one another, who are not even personally known to one another, and who under different circumstances might have been knit together in closest fellowship, has for me no bright side. This driving of thousands upon thousands of a nation's picked manhood to the shambles, this wanton carnage, to say nothing of the loss of productive energy and the colossal destruction of wealth, is, one feels instinctively, wrong; the horror is only equalled by the inanity of it.

But though actual war is detestable, yet it must be confessed that indirectly it serves a useful purpose in that the fear of it leads a nation to exercise itself in the virile pursuit of arms and to hold itself in readiness to meet an enemy, while actual war rouses the community to put forth supreme efforts; and this striving to overcome a threatened or actual danger works beneficially and leads to the development of latent possibilities in a manner undreamt of in the easy-going times of peace.

Nothing but the call of actual war could have aroused our country to accomplish what it has accomplished since the July of 1914. What other impelling force could have induced us to increase our national expenditure tenfold, to liberate vast stores of unused energy, to transform the whole economic life of the people, to sacrifice by tens of thousands the flower of our manhood, as has been done since the declaration of the war? All of which goes to show how great things a nation can accomplish once the necessary stimulus is forthcoming. If only some equally effective stimulus could be found in times of peace, one which should impel to similar energetic action, not for the purpose of slaughter and destruction, but for the common good! What might not be accomplished if all the energy and ingenuity and self-sacrifice which we have devoted to the prosecution of this war had been directed to the clearing out of the slums of our cities and to the providing for the toiling millions healthy, well-appointed, and beautiful homes? Our present experience should serve to bring forcibly before us the fact that we have it in our power to do all this and much more. All that is needed is the proper organization and distribution of our

activities—*and the adequate stimulus.* But how to get the stimulus is the difficulty. I fear that nothing but a great external danger such as we are now facing is capable of supplying it. Theoretically a great religious revival might suffice, but it would have to be one which concerned itself not so much with the attainment of a possible heaven in another world as with the removal of some of the evils suggestive of another place in this one.

Strange as it may seem, and contrary as it may be to our predilections and *a priori* conceptions, the condition of peaceful ease in which we picture the lion lying down with the lamb is, from nature's point of view, far from the ideal. A community long lulled in a state of blissful ease is bound to deteriorate, for all healthful life implies struggle. Man needs to be roused from the apathy into which he so easily slips by difficulties to overcome, and there is no more arousing stimulus than the apprehension of danger.

Few will deny that when the present world-war burst upon us we had as a nation grown lax and inert through long years of ease and luxury, and that whatever may be said of the ultimate effect of the war on the other belligerents, the people of these islands and of the British Empire as a whole will be greatly benefited by it. For not only has it tightened the bonds which unite the units of the Empire, but it has awakened undreamt-of stores of dormant activity, and I go as far as to believe that the greater the difficulties we may still have to contend with—the tighter the corner in which we may find ourselves, the more we may be compelled to fight with our backs to the wall—the better will it be for us individually and for the Empire at large; for it is only through struggle, fierce and sustained, that an individual or a nation can realize itself to the full. Struggle has been a necessary factor in evolution. It is the normal condition of every living thing, save those degraded parasites which inhabit the interior of their host and pay the penalty of their parasitism by a corresponding degradation in structure and function; for it is a primal law of nature that once the need for struggle is removed degeneration sets in. Hence one of the great social problems confronting man in the future will be how, without having recourse to war with all its horrors, to counteract the enervating and degenerating effects of the ease and luxury which tend to be shared by a considerable section of every prosperous community. In the perfect State the conditions would be such as to render such enervation impossible. Every able-bodied person would be compelled to pull his full weight in the ship of State—to play his part in that healthful struggle which is essential to adequate development. Pure parasitism, which prevails all too widely among us, would be debarred save in the case of the diseased and decrepid. To sanction it is unjust to the individual, though he may not know it, and unjust to the State. (In insisting upon struggle as essential to development, individual and national, I do not, of course, mean that it should be so severe as to be paralyzing. No one would contend, *e. g.*, that conditions of abject poverty can have any other than evil results.)

If I am asked how a nation, once peace and prosperity are secured to it, is to be kept engaged in bracing struggle and prevented from lapsing into enervating ease, I reply that I have no panacea. This desirable end can only come through enlightenment. But while so many evils to be set right still remain within the body-politic, while so many social questions of the gravest urgency press increasingly upon us, while all Europe has to be rebuilt and its new world relations to be readjusted, it is safe to say that it will be long years before we shall be in any danger of relapsing into dreamful ease and before that times comes the enlightenment may have come also. Moreover,

> . . . Man is not man as yet.
> When all mankind alike is perfected,
> Equal in full-blown powers—then, not till then,
> . . . begins man's general infancy.

[TO BE CONCLUDED]

The Uniflow Engine

By H. W. Morley, M. I. Mech. E.

THE uniflow, or central exhaust engine, as it is better called, like most other engines, has its limitations in economical use. Like most other good things, it has had its failures, mostly due to its being used for purposes for which it was unsuitable, and, in this country, in many cases to bad workmanship and improper design.

The central exhaust is eminently suitable for condensing engines, and in this case an auxiliary device is only necessary to save the engine in case of failure of the condenser where the air pump is operated from the engine itself, to assist in starting. This is successfully done by several manufacturers either: (1) By fitting a valve, by preference automatic in its action, to increase the clearance space; (2) by fitting a partially balanced spring-loaded escape valve, discharging into the exhaust pipe; (3) by fitting exhaust valves, mechanically operated. As it is only necessary to exhaust part of the working steam this valve only requires a small area. The mechanical gear may come in and out of operation either by hand, or as used by one maker, automatically, when the vacuum is absent.

The central exhaust ports are in practice limited in area, but there is no difficulty in so proportioning them that piston speeds between 600 feet and 700 feet per minute can easily be obtained, for condensing engines, without scarificing any convenience or economy.

The natural properties of the engine make it eminently suitable for higher speeds of revolution than obtain in the usual slow speed engine practice; hence it opens a new field for those makers who have generally confined themselves to that type. But it must be taken as a whole, demanding, for the best results in economy of working, a complete new set of designs and patterns. The workmanship will require to be good, better than the average of our slow speed engine makers, but no better than that of our best makers, for all details of design are existent in our British practice. The piston is the most difficult part to design and manufacture, as it must be as light as possible, the rings strong but flexible, and so made as accurately to fit the cylinder on their bearings, yet allowing enough for the expansion, especially when superheated steam us employed. Many of our manufacturers will either not admit, or do not know, that commercial steam cylinders are not truly cylindrical, and that there are limits of inaccuracy beyond which they cannot successfully go; these limits are closer in the central exhaust engine than in engines with shorter pistons.

The steam consumption results obtained with the central exhaust engine at normal pressures and temperatures for stationary engine work have been better than those obtained with compound engines up to about 300 horse-power; above this size, to about 600 horse-power, there does not seem much difference, but above this power the compound engine, with valves in the cylinder head, does, at present, appear to give the better results. But economy in steam is not the most important factor in a really commercially economical engine. In most works and factories reliability is the first and foremost consideration, since one hour's involuntary stop per annum easily equals in cost one pound of steam per horse-power hour, and it may be a surprise to many readers to hear that there are hundreds of slow speed steam engines at work whose records show less than one hour's involuntary stop for every 5,000 hours they should run. Next in consideration is capital cost, especially where the works or factories run only 54 to 56 hours per week.

Summing up, it may be said that the central exhaust engine, correctly designed and carefully manufactured, being simpler and cheaper than the ordinary type, should have a wide and varied field for factory and works use, and it seems as though it would well repay our slow speed engine builders to take the advantage of entirely redesigning their engines, of simplifying them, adding forced lubrication, and standardizing them, and instead of building to order, build to stock. The result would be of considerable advantage to themselves and the users.

The central exhaust engine may be worked high pressure, but then the clearance volume must be increased, and it has yet to be proved that, under these conditions, its economical results even equal those of an engine of ordinary type. Should the designer decide to add an exhaust valve, in order to reduce the clearance volume, which valve must be kept in continuous operation, it does not appear that the compromise has any advantage over the ordinary engine.—*The Engineer.*

The Efficiency of Man

IN a recent issue of the London *Times* Prof. Leonard Hill has an interesting letter on scientific rationing. He points out that as a machine the efficiency of a man is about 25 per cent, three times as much heat being produced as external work done. During complete rest in bed, fasting, the energy spent in the internal work of the body is determined. This averages one calorie per kilogram of body-weight per hour for all average people—about half the expenditure of the man doing light work. All unproductive people, idlers, old, and invalid, can save a large part of the food they eat by lying in bed, warm and at rest. With regard to different classes of workers, the same measure of meat is not suitable for them all, because meat, far more than carbohydrate or fat, stimulates the living cells to live at a vigorous rate. Prof. Hill states that experience shows that the higher class of brain-workers, the organizing and driving power of the nation (which must not be lessened), secures its energy most easily out of a diet containing a higher proportion of meat, and that carbohydrate is utilized very well by producers of mechanical work. He says that the Yapp ration, considering the difficulty of securing all the rationed foods, affords scarcely more than half the energy necessary for productive labor. "At current prices flour yields more than 700 calories for a penny, meat and cheese about 100, margarine 300. To ration bread and flour, then, should be the last measure of emergency; the physiologist cannot conceive rationing these while luxury trades continue and fields are not fully cultivated or ships built to the utmost; while spirits are distilled from foodstuffs for munitions, and great stores of alcohol are left untouched; while the problem of transport of potatoes and swede turnips to the urban populations has not been solved; while shipping is not used to the maximal advantage to maintain the importation of cereals."

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